(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number : **0 617 927 A1**

(12) EUROPEAN PATENT APPLICATION

(21) Application number : **94302143.6**

(51) Int. Cl.^{5} : **A61B 17/58**

(22) Date of filing : **24.03.94**

(30) Priority : **28.03.93 IL 10518393**

(43) Date of publication of application :
05.10.94 Bulletin 94/40

(84) Designated Contracting States :
CH DE ES FR GB IT LI

(71) Applicant : **Gotfried, Yehiel**
10, Ben Gurion Ave
Kiryat-Bialik (IL)

(72) Inventor : **Gotfried, Yehiel**
10, Ben Gurion Ave
Kiryat-Bialik (IL)

(74) Representative : **Clifford, Frederick Alan**
MARKS & CLERK,
57/60 Lincoln's Inn Fields
London WC2A 3LS (GB)

(54) Surgical device for connection of fractured bones.

(57) A surgical device for percutaneous connection of a fractured upper part of the femur to the shaft comprises : a connector plate (I) with a lower straight portion for screwed connection to the femur shaft and with a sharp bottom end (8) for insertion through a small skin incision, having its upper portion perforated by two oblique, tapped bores (5) for fixation of two long screws (II) serving for connection of the fractured parts. Each screw has a wood-screw-shaped inner end (11) and a cylindrical shaft (10) with a hexagonal recess (12) at its outer end which is continued by a tapped bore (13). Each screw is slidingly positioned in a sleeve (III) which has its outer end slotted and screw-threaded (16,15) for fixation in the oblique bores of the plate. The connector plate is positioned and fastened to the femur by an angular connector arm (IV) composed of a short horizontal arm (20) for firm perpendicular connection to the top of the plate (I) by a long screw (22), and a vertical portion (21) parallel to the plate provided with bores (26) coaxial with the bores (5) in the plate for guidance of the screws by means of a set of tubular guides.A screwdriver (V) contains a central shaft (40) having a screw-threaded inner end (41) for engagement with the tapped bores in the screw ends, an intermediate tubular shaft (43) having its inner end (44) hexagonally shaped for engagement with the recesses (12) in the screw ends, and an outer tubular shaft (47) provided with teeth (48) for engagement with the slots (16) in the sleeve ends. All three shafts can be independently rotated and axially moved by separate grips (42,45,49) at the outer end of the screwdriver.

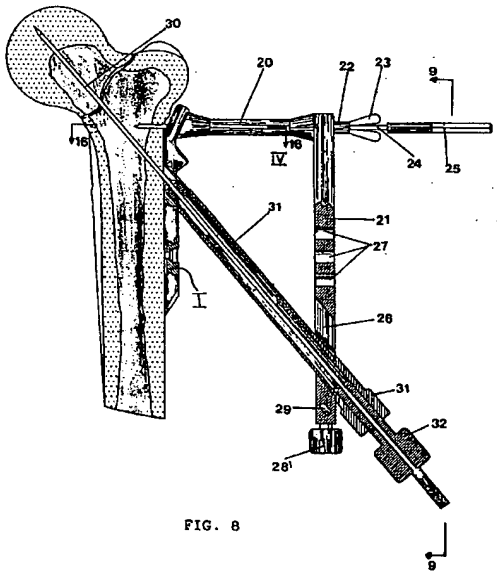

FIG. 8

EP 0 617 927 A1

BACKGROUND OF THE INVENTION

The present invention is an improvement of the surgical device disclosed in my U.S. Patent No. 4,465,065. It serves for connection of the fractured neck to the shaft of a femur by means of a pre-drilled connector plate, without the requirement of making a large incision in the overlying skin and tissue.

The connector plate according to the above patent and according to the present invention has a sharp lower edge by which it penetrates through a small incision in the trochanter region into close contact with the shaft. During the operation the plate is temporarily attached to the horizontal portion of a connector arm, while its vertical portion extends parallel to the plate and is provided with holes which are coaxial with the holes in the plate. Concentric guide tubes are inserted through the holes in the vertical portion of the connector arm, are pushed through the soft tissue up to the plate and serve as guides for predrilling of the bone parts in the correct position as viewed by X-ray equipment. After pre-drilling the inner guide tubes are removed and the outer tubes serve for insertion of long screws, and are afterwards removed. The long screws are tightened so as to contract the fractured parts. Short screws serving for firm attachment of the plate to the femur shaft are now inserted through the vertical portion of the connector arm, after suitable drilling through tubes inserted into hcles in the arm, which are co-axial with the holes in the plate. The connector arm is now detached from the plate, and the wound is closed. The present device is similar and serves the same purpose, but is designed to avoid certain drawbacks of the original device which have come to light during its use in operations of the kind referred to. The following main drawbacks were observed:

The long screws did not permit active compression of the fractured bone parts, a task which is most important for quick healing of the bone and for early use of the limb by the patient.

The long screws were not sufficiently guided in the holes of the connector plate and were apt to wobble, often resullting in instability of the fracture after connection.

The screws were apt to protrude out of the bone into the soft tissue, after walking of the patient had started and the fracture had been pressed.

The connector plate was not firmly fastened to the femur during operation, which made drilling difficult.

The device according to the present invention aims to obviate these drawbacks by providing improved components which facilitate and shorten the progress of the operation on the one hand, and hold the fractured parts in full alignment and under compression after their complete jointing, on the other. In addition, sufficient space is provided for axial sliding out of the connecting screws, while preventing their protrusion out of the connector plate.

SUMMARY OF THE INVENTION

Before going into constructional details of the device,it should be noted that the following directional expressions will be employed in respect of the femur bone, the tool, the connector plate and the screws during the operation:- the expressions "top" and "upper portion" of any part will refer to the femur top, and the "bottom" or "lower portion" will refer to the direction towards the knee joint. The expression "inside" or "inner portion" will refer to parts close to the bne outside or pointing towards it, while the expression "outside" or "outer portion" will refer to those parts which are outside the human body operated on, or pointing away from the bone.

The improved surgical device for connecting and securing the fractured neck to the femur shaft includes:-

A. Components which are to remain in the body after completed operation:-

1. A connector plate of substantially rectangular cross section comprising a straight lower portion which has a sharpened lower end permitting its insertion through a small incision in the skin and its being pushed through the soft tissue along the femur into its final position. Its upper end is short and bent outwardly to conform to the contour of the bone; it is perforated by a screw-threaded bore and at least one straight bore which serve for its connection to a holding tool. The upper part of the straight portion is perforated by two obliquely directed and screw-threaded bores, and the lower part is perforated by two or more straight, counter-sunk bores, all of which are used for guiding the drills for pre-drilling of the bone parts and for insertion of screws for firm attachment of the plate to the femur shaft and for connection of the fractured bone parts.
2. Two long screws used for connecting the fractured parts to the connector plate have their outer ends firmly guided and lengthwise and rotatably movable in relatively short sleeves; they extend through the upper bores through the femur neck and are screwed into the head portion; The outer ends of the sleeves are firmly held in the screw-threads of the two upper bores of the plate, thereby keeping the screws in firm position, while permitting axial movement; the outer ends of the screws are recessed each comprising a coaxial recess of hexagonal or other polygonal cross section which is continued by a screw-threaded bore. The inner ends of the sleeves are slightly crimped preventing the screws

from escaping out of the sleeves by contact with a step on the screws.

3. Two or more short screws securing the lower plate portion to the femur shaft, having their heads hidden inside the counter-sinks.

B. Auxiliary equipment for insertion and fixation of the permanent components:-

1. An angular connector arm, including a short horizontal portion for connection to the upper end of the connector plate and a longer vertical portion extending parallel to the direction of the connector plate;the vertical portion is perforated by two obliquely directed boresband by two or more straight bores, all of them coaxial with the bores of the connector plate, but of larger diameter, permitting the passage and fixation of guide tubes. It is preferably provided with set screws for locating the guide tubes and with means for attaching of an aiming device at its bottom end. The short horizontal portion is lengthwise perforated and contains a long screw and at least one protruding pin for engagement with the screw-threaded bore and the straight bore in the upper end of the connector plate.

2. Two long composite guide tubes of a length sufficient to extend through the bores in the connector arm to the corresponding oblique bores in the connector plate; they include an outer tube of an inner diameter corresponding to the diameter of the screw to be inserted and to be screwed into the fractured neck, and two inner, removable tubes, viz. a first tube concentrically bored to the diameter of a guide wire to be pushed therethrough into the bone, and a second tube concentrically bored to the diameter of a drill adapted to drill the bone for reception of the two long screws.

3. Two or more shorter guide tubes for insertion into the straight bores in the connector arm up to the corresponding bores in the connector plate serving for predrilling the bone before final insertion of the screws for firm attachment of the connector plate to the femur shaft.

4. A special screw driver adapted for inserting and fixing the long screws and their sleeves in the connector plate and in the fractured bone parts, and for compressing the fracture after its connection.

The auxiliary equipment is removed from the body after the connector plate has been firmly connected to the femur shaft and the fracture has been connected and duly compressed by means of the long screws, whereafter the wounds are to be dressed.

The operation is carried out as described before in connection with the device disclosed in US.4,465,065, with the difference that according to the present invention the long screws are axially movable, both active and passive, in their respective sleeves which have their screw-threaded ends firmly connected to the bores in the connector plate. This feature permits active compression of the fractured parts by the surgeon and preventing the drawback of the previous invention of gradual protrusion of the screw heads into the soft tissue with subsequent irritation and pains. In addition, the improved auxiliary equipmert according to the present invention not only facilitates the operation, but requires less time than before, a boon both for the patient and the surgeon.

The manner and sequence of operating on a fractured femur neck will be described in detail with reference to the drawings showing the various permanent and auxilary components of the device.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a side view and part section of the connector plate,

Figure 2 is a plan view of the connector plate illustrated in Figure 1,

Figure 3 is a side view of a long screw,

Figure 4 is a section through the outer end of the screw illustrated in Figure 3,

Figure 5 is an end view of the screw illustrated in Figure 3,

Figure 6 is a longitudinal section of the sleeve covering the outer end of the long screw,

Figure 7 is a side view and part section of the long screw positioned in the sleeve of Figure 6,

Figure 8 is a sectional view of the connector plate, the connector arm and auxiliary equipment at the beginning of an operation,

Figure 9 is an end view of the connector arm along line 9-9,

Figure 10 is a sectional view of the connector plate, the connector arm, and the screwdriver, showing an advanced state of the operation, with one long screw and sleeve in position and a second screw in its way to its final position,

Figure 11 is a longitudinal section through the screwdriver used in inserting the long screws and their sleeves,

Figure 12 is a drawing showing a stage of the operation while using a rod-shaped aiming device,

Figure 13 is a side view and part section of a second embodiment of the connector plate,

Figure 14 is a plan view of the connector plate illustrated in Figure 13,

Figure 15 is a section along line 15-15 of Figure 14,

Figure 16 is a section along line 16-16 of Figure 8, showing connection of the connector plate of Figure 13 to the connector arm, and

Figure 17 is a longitudinal section of another embodiment of the screwdriver illustrated in Figure

11.

DETAILED DESCRIPTION OF THE DRAWINGS

The connector plate I illustrated in Figures 1 and 2 includes a straight lower, main portion 1 and a head portion 2 outwardly bent in respect of the main portion, to conform to the contour of the bone. The head portion contains one larger, screw-threaed bore 3 and two smaller bores 4 for connection to the horizontal portion of the connector arm as will be described in detail further on. Next to the head portion two obliquely directed, screw-threaded bores 5 penetrate the main portion at an angle of about 130°, the outer surface of the portion being thickened by two lugs 6 permitting a greater length of the bores 5. Underneath the two bores 5 three countersunk bores 7 are drilled through the main portion at right angles thereto. The lower end of the main portion is sharpened (8) having the purpose of penetrating through the soft tissue and muscles close to the femur shaft during its insertion through a small out in the skin.

One of the two long screws II and its sleeve III is illustrated in Figures 3 through 7:- Herein the screw includes a relatively long shaft 10, an inner end provided with screw thread 11 similar to that provided on wood screws, and an outer end recessed in the form of a hexagon 12 continued with a screw-threaded bore 13 of smaller diameter. The outer end of the screw is slidably, but tightly, inserted into the inner bore of a sleeve 14, which has its outer end provided with outside screw thread 15 and slotted by two or four slots 16 serving to engage the special screw driver to be shown in Figure 11. The assenbled screw and sleeve are shown in Figure 7, part in side view and part in section. The inner end of the sleeve is inwardly crimped (18), thereby preventing the screw from sliding out of the sleeve by contact with a step 17 on the screw shaft. The three screws connecting the plate to the shaft of the femur by means of the three bores 7, are not shown as of the usual kind and size used in similar operations.

Figures 8, 9 and 10 illustrate the auxiliary equipment serving for insertion and tightening of the long screws and for compressing the fractured bone parts after insertion of the screws. The main instrument is an L-shaped connector arm IV which includes a horizontal portion 20 and a vertical portion 21 firmly connected to each other at right angles. The horizontal portion is provided at its inner end with two pins (not visible) engaging the bores 4 of the connector plate and serving to ensure exact parallel alignment of the connector plate with the vertical portion. A connecting screw 22 extends through a central bore in the horizontal portion and connects the connector arm to the plate by engaging the screw thread 3 in the latter, being actuated by a grip 23. At the same time two pins enter the bores 4 and prevent relative rotation of connector plate and arm. The screw 22 is hollow to permit passage of a long, pointed bar 24 provided with a grip 25 for forceful insertion into the bone and for exact location of both the connector plate and the connector arm.relative to the femur bone. The vertical portion contains two large, obliquely directed bores 26 which are coaxially aligned with the bores 5 in the connector plate, but of larger diameter. Above the two bores 26, three smaller bores 27 are drilled through the portion at right angles thereto and coaxially aligned with the bores 7 of the connector plate. Set screws 28 penetrate the sides of the bores 26 and 27 and serve to hold the tubular guides in position.An additional feature of the connector arm is in the form of an oblong hole 29 perforating the lower end of the vertical portion and adapted to hold a rod-shaped aiming device which is secured by a set screw 28'. Figure 12 shows the aiming device in position, as well as the X-ray equipment positioned above and below the fracture to be connected.

Figure 8 likewise illustrates a first stage of an operation carried out by means of the device: after the connector plate has been inserted into the thigh through a small cut and has been slid into an approximate position as viewed by means of X-ray equipment and the aiming device; its correct location in relation to the neck portion is found by means of a guide wire 30 which is inserted into the bone material of the femur shaft and into the bone of the neck through an inner tubular guide (32) located within an outer tube 31 extending through the bore 26 of the connector arm into the screw-threaded bore 5 of the connector plate. The inner tubular guide 32 is screwed into bore 5 of the plate in order to permit exact centering of guide wire 30 and to prevent its disengagement from the connector plate. In case of incorrect location the guide wire is withdrawn, the connector plate is moved by means of the connector arm into another position and the guide wire is again inserted into the bone. In the case the location is found to be correct as seen by X-ray viewing, the pointed bar 24 is forcefully pushed into the bone to finally fix the position of bone and plate, whereupon the guide wire 30 and the inner tubular guide (32) are removed. They are replaced by the second inner tubular guide of wider inner bore, and a drill is inserted therethrough which, by mechanical rotation, drills holes into the shaft and the neck for subsequent insertion of one of the long screws.

The special screwdriver V as illustrated in Figure 11 comprises three concentrically aligned shafts which are independently movable in both axial and rotary direction. They include:

1. an innermost shaft 40 with a screw-threaded end 41 suitable for engaging the bore 13 in the rear end of the long screws and for rotation by a grip 42 at the outer end of the screw driver.
2. an inner tubular shaft 43 having a hexagon-shaped end 44 for engagement with the hexago-

nal recess 12 in the long screws. It can be rotated for driving the screw into the pre-drilled bone material by means of a cylindrical grip 45 via a disc 46 firmly mounted on the shaft 43.

3. An outermost tubular shaft 47 having an inner end in the form of cross-wise aligned edges 48 for engagement with slots 16 in the screw sleeves III. It can be rotated for the purpose of screwing the sleeves into the connector plate by means of a cylindrical grip 49.

4. An outer sleeve 56 rotationally and longitudinally movable on the inner movable shaft 43. It is provided with a circumferential recess 58 engaged by a pin 59 serving to limit the longitudinal motion of the shaft. A seconnd circumferential recess is provided at the other end of sleeve 56e and engages a stop 57.

The components can be axially moved relative to each other, but are urged into their normal position by helical springs 50 and 51, while additional axial motion of the tubular shaft 43 is made possible by withdrawal of stop 57; their specific use will be explained further on in connection with the final stage of the operation.

The final stage of the operation of connecting a fractured head to the femur shaft is illustrated in Figure 10, as follows:-

After the bone has been drilled through the oblique bores the inner tubular guide is removed. Now the two long screw-and-sleeve assemblies are inserted and fastened, one after the other, with the aid of the screw driver V, as follows:- a screw II is pulled back into a sleeve III up to its outer end, and the hexagon-shaped end 44 of the screwdriver is pushed into the correspondingly shaped recess 12 in the screw end. By rotating grip 42 and pushing it against the force of helical spring 51, the threaded end 41 of the innermost shaft 40 of the screwdriver is screwed into screw-threaded bore 13 of the screw, while the protruding edges 48 of the outermost tubular shaft 47 are urged into slots 16 in the end of sleeve III by means of helical spring 50. Additional tightening of the screwed end 41 into bore 13 connects and firmly secures the screw-and-sleeve assembly to the screwdriver. By means of the screwdriver the assembly is now pushed in inward direction through the outer tubular guide 31, and rotated as far as the screw-thread on the sleeve III allows, and the sleeve is screwed into bore 5 of the connector plate by rotation of grip 49. By pulling out the stop 57, grip 45 which is connected to the inner shaft 43 by means of collar 46, can be moved in inward direction thereby pushing shaft 43 inwardly. By rotating and pushing grip 45 inwardly, screw II is moved along sleeve III and is urged towards the fractured head portion and inserted into the pre-drilled bore in the bone material, rotation being stopped as soon as it has reached the required depth as viewed by X-ray equipment, or whenever step 17 on the screw has reached the crimped end 18 of the sleeve. A pin 60 engaging with a circumferential groove 61 limits the distance to which grip 42 can be moved in outward direction, while being urged there by spring 51. In addition, during fracture compression pin 60 transfers the load from grip 45 to shaft 40 via grip 42. In order to pull the fractured head in direction of the femur shaft and thus to compress the fracture, a retracting device VI is attached to the grips 45 and 49 by means of pins 52 inserted into corresponding holes 53. By rrotating the handwheel 54, screw 55 pulls grips 49 and 45 apart as well as grip 42 (by means of pin 60),thereby pulling the attached screw I into the sleeve which is firmly screwed and secured in the plate. After insertion and fixation of the first screw, pointed bar 24 is removed and the second screw is inserted into the fractured parts in the same manner.

After insertion of both long screws, the connector plate is firmly attached to the femur shaft by means of two to three shorter screws. For this purpose a shorter tubular guide is inserted into the tissue through one of the bores 27 of the connector arm and secured by a set screw 28. Thereafter the bore is drilled in the conventional manner and a screw 33 is inserted with its head positioned in the countersink of the bore 7, preventing its protruding out of the plate. After all screws have been fixed, the connector arm is removed from the plate and out of the body by detaching screw 22, the skin incisions are closed and the wounds are dressed.

Figures 13, 14, 15 and 16 show a' simplified version of the connector plate illustrated in Figures 1 and 2.It differs from the earlier version by omission of the outwarrdly bent head portion 2, the two small bores 4 and of the two lugs 6, the other components being identical in both embodimerts and marked by identical numerals. The present connector plate has a thicker upper portion, while the lower portion is of about the same thickness as that shown in Figure 1. Instead of the bent head portion the underside of the thickened upper portion is cut away at a slant (102) corresponding to the shape of the femur. The two lugs 6 appearing in Figure 1 are necessarry to permit a sufficient length of the screw thread 5, but owing to the greater thickness of the present plate there is sufficient material for these bores. The two bores 4 of Figure 1 are necessary for connection to the connector arm by means of two pins engaging with the bores; the present connection is made by engagement of the concave end of the arm (120) with the rounded top surface of the connector plate (v.Figure 15), thus keeping the two in firm and straight alignment.

A second version of the screwdriver V is illustrated in Figure 17, wherein the means for moving the grips 49 and 45 apart is by means of a cup-shaped spacer 62. The spacer is provided with inner screwthread cooperating with outer screwthread on grip 49. By rotation of the spacer it is moved to the rear until

it contacts grip 45 and moves grip 42 via pin 60 to the rear, thereby pulling screw II rearwardly into the sleeve by means of screw 41 engaging the tapped bore 13 in the screw end, and thus compresses the fracture.

Figure 12 illustrates the shape and use of an aiming device which is an additional feature of the invention. The device is used at the beginning of the operation to locate the optimal final position of the screws to be inserted into the fractured bone. It is attached to the connector arm 21 and is adjusted in the direction of the fracture from the outside of the thigh. By viewing the position of the aiming device in relation to the femoral neck by X-ray equipment (63,64) the position of the connector plate and the auxiliary equipment can be adjusted and brought into the most suitable location.

The aiming device comprises an aiming rod 60 connected to the end of a connecting bar 61 at right angles by clamping means 62. The connecting bar is held in position in the hole 29 at the bottom end of the connector arm 21 and secured there by means of the set screw 28'. After adjustment of the connector plate the aiming device can be detached. As known to the art, all further stages of the operation are likewise controlled by X-ray viewing.

It is reiterated that a few of the described stages of the afore described percutaneous operation are resemble those described in my United States Patent No. 4,465,065, but that most components of the present device have been changed and modified. The improvements over the surgical device described in my earlie patent are:- fixation of the long screws in sleeves, permitting their axial sliding motion without protrusion out of the bone and soft tissue; ready insertion of the long screws by means of special tooling, and active compressing of the fracture after insertion of the long screws, again with the aid of the special screwdriver. In addition, modification of the connector plate enhances stability of the junction between plate and screw, while the temporary fixation of the plate to the femur by means of the pointed bar 24 ensures high accuracy in pre-drilling of the bone.

In case only one long screw is to be inserted into the fractured bone, only one of the olique bores (5) in the connector plate and one of the bores (26) in the connector arm will be used or, alternatively, both the connector plate and the connector arm are provided with one oblique bore only. In the latter case, a bolt of somewhat larger diameter may be used together with a correspondingly larger sleeve and larger bores in the device components.

It will be understood that the outer shape and form of the different components, both permanent and auxiliary, have been designed with the object of performing the task in hand at maximum convenience for the surgeon and in a mimimum of time, by obviating change of tools and equipment as found necessary with conventional devices. However, they may be changed or modified as long as they will serve to perform the afore described steps of the operation, i.e. connecting and compressing the fractured parts for the benefit of the patient, while maintaining the percutaneous surgical technique.

Claims

1. A surgical device for percutaneous connection of a fractured upper part of the femur to the femur shaft, comprising the following components to remain in the body:-

   a bar-shaped connector plate (I) having an inner surface to be placed onto the bone, an outer surface, a head portion and a bottom provided with a sharpened end (8) for its insertion through a small incision in the skin, said connector plate being provided in its lower portion with at least two countersunk, through-going bores (7) and in its upper portion with two adjoining oblique, screw-threaded bores (5) of larger diameter directed in upward direction at an angle of about 130°, a screw-threaded bore (3) perpendicular to the axis of said bar-shaped connector being provided in said head portion,

   two long screws (II), each screw having a straight shaft (10), a wood-screw-shaped inner end (11) for insertion into said fractured bone part and an outer end coaxially recessed (12) in hexagonal or other polygonal shape, said recess being continued by a screw-threaded bore (13) concentric with said shaft axis, the outer end portion of each said screw being positioned and movable in both axial and rotational direction in a sleeve (III) of shorter length than said screw, the outer end of said sleeve being provided with screw-thread (15) corresponding to the screw-thread in said oblique bores in said connector plate and with at least two recesses (16) for engagement of a screwdriver,

   at least two shorter screws (33) for securing said connector plate (I) to the femur shaft, extending through said straight bores (7)into the bone material.

2. Auxiliary equipment serving to insert and to connect to the fractured bone the equipment as defined in Claim 1, comprising:

   an angular connector arm (IV) including a short horizontal portion (20) for connection to the head portion of said connector plate and a longer vertical portion (21) extending parallel to the straight lower portion of said plate, wherein said horizontal portion is provided with an axial perforation for passage of a screw (22) engaging with said screw-threaded bore (3) in said head portion

of said plate and is shaped to conform to the shape of said head portion to ensure absolute parallelity of said vertical portion (21) with said connector plate, and wherein said vertical portion is provided with two adjoining obliquely directed bores (26) coaxially aligned with said two screw-theaded bores (5) in said connector plate, and with at least two straight bores (27) coaxially aligned with said at least two straight bores (7) in said plate,

a tubular guide (31) of an outer diameter cooperating with said oblique bores in said connector arm and of an inner diameter corresponding to the outer diameter of said sleeve covering said long screw, of a length compatible with the distance between the respective oblique bores in said plate and said arm,

a first removable tube (32) for insertion into said tubular guide of an inner diameter corresponding to the outer diameter of a guide wire (30) to be pushed therehrough into said fractured bone,

a second removable tube for insertion into said tubular guide of an inner diameter corresponding to the diameter of a drill for pre-drilling said bone,

a guide wire (30) to be pushed through the bore in said first removable tube,

a drill to be inserted into the bone material through the bore in said second removable tube,

a tubular guide for insertion into said straight bores (27) in said connector arm, of a length compatible with the distance to said connector plate, and of an inner diameter suitable for the passage of a drill destined for pre-drilling the bone for acceptance of said shorter screws (33),

a screw-driver (V) for insertion and fixation cf said long screw composed of an inner shaft (40) provided with a screw-threaded inner end (41) for engagement with said screw-threaded bore (13) in the recessed end of each long screw, of a median tubular shaft (43) provided with a polygonal inner end (44) for engagement with said polygonal recess (12) in each long screw. and of an outer tubular shaft (47) provided at its inner end with protruding teeth (48) for engagement with said recesses (16) in said sleeves covering said long screws, wherein all three shafts are independently movable in both axial and rotational direction by grips (42,45,49) attached to their outer ends, and wherein helical springs (50,51) are provided serving to adjust the axial alignment of the respective shafts.

3. The surgical device as defined in Claim 1, wherein the outer portion of said connector plate surrounding said oblique screw-threaded bores is thickened in the form of two oblique lugs (6) protruding out of the plate surface.

4. The surgical device as defined in Claim 1, wherein the head portion (2) of said connector plate (I) is bent outwardly to conform to the contour of the femur ,and wherein said head portion is perforated by said screw-threaded bore (3) and by at least one smooth bore (4), both bores being perpendicular to the axis of said connector.

5. The surgical device as defined in Claim 1, wherein the inner surface of said head portion of said connector plate slopes outwardly (102)in accordnce with the contour of said femur.

6. The surgical device as defined in Claim 1, wherein the outer surface of the head portion of said connector plate is convex.

7. The surgical device as defined in Claim 1, wherein each of said long screws (II)is provided with a circumferential step (17), and wherein the inner end (18) of each said sleeve is inwardly crimped, to prevent said screw from sliding out of said sleeve, owing to contact of said step with said crimped end.

8. The surgical device as defined in Claim 2, wherein said vertical portion of said connector arm is provided with set screws (28) serving to secure said tubular guides.

9. The surgical device as defined in Claim 2, wherein the inner end (120) of said horizontal portion of said connector arm is concave to correspond with the convex head portion of said connector plate.

10. The surgical device as defined in Claim 2, wherein the lower end of the vertical portion of said connector arm is provided with means (28',29) for holding a rod-shaped aiming device (60,61,62).

11. The surgical device as defined in Claim 10, wherein said aiming device comprises an aiming rod (60) connected at right angles to a connecting bar (61), said connecting bar being adapted to be attached to the bottom end of said vertical portion of said connector arm by means permitting adjustment of the angular direction of said aiming bar.

12. The surgical device as defined in Claim 2, wherein said screwdriver is provided with means for pulling the screw-threaded end of said inner shaft into said outer tubular shaft, serving to pull said long screw in outward direction relative to said sleeve.

13. The surgical device as defined in Claim 2, wherein said screwdriver is provided with an outer sleeve (56) held in position by a removable pin (57) and engaging said outer tubular shaft(47) by means of a pin (59) movable along a circumferential recess (58) on the outside of said sleeve.

14. The surgical device as defined in Claim 2, wherein said screw (22) extending through said horizontal portion of said connector arm is provided with a grip (23) at its outer end and is centrally perforated permitting the passage of a sharp pin or screw (25) to be pushed into the bone for exact fixation of said connector arm.

15. The surgical device for percutaneous connection of a fractured neck portion of a femur as defined in Claims 1, 3, 4, 5, 6, and 7, and substantially as hereinbefore described with reference to the accompanying drawings.

16. The auxiliary equipment serving to insert and to connect to a fractured bone the surgical equipment of Claim 1, as defined in Claims 2, 7, 8, 9, 10, 11, 12, 13 and 14 and substantially as hereinbefore described with reference to the accompanying drawings.

17. A surgical device for percutaneous connection of a fractured upper part of the femur to the femur shaft, comprising the following components to remain in the body:-

a bar-shaped connector plate (I) having an inner surface to be placed onto the bone, an outer surface, a head portion and a bottom provided with a sharpened end (8) for its insertion through a small incision in the skin, said connector plate being provided in its lower portion with at least two countersunk, through-going bores (7) and in its upper portion with oblique, screw- threaded bore (5) of larger diameter directed in upward direction at an angle of about 130°, a screw-threaded bore (3) perpendicular to the axis of said bar-shaped connector being provided in said head portion,

a long screw (II), having a straight shaft (10),a wood-screw-shaped inner end (11) for insertion into said fractured bone part and an outer end coaxially recessed (12) in hexagonal or other polygonal shape, said recess being continued by a screw-threaded bore (13) concentric with said shaft axis, the outer end portion of said screw being positioned and movable in both axial and rotational direction in a sleeve (III) of shorter length than said screw, the outer end of said sleeve being provided with screw-thread (15) corresponding to the screw-thread in said oblique bore in said connector plate and with at least two recesses (16) for engagement of a screwdriver,

at least two shorter screws (33) for securing said connector plate (I) to the femur shaft, extending through said straight bores (7)into the bone material.

18. Auxiliary equipment serving to insert and to connect to the fractured bone the equipment as defined in Claim 1, comprising:

an angular connector arm (IV) including a short horizontal portion (20) for connection to the head portion of said connector plate and a longer vertical portion (21) extending parallel to the straight lower portion of said plate, wherein said horizontal portion is provided with an axial perforation for passage of a screw (22) engaging with said screw-threaded bore (3) in said head portion of said plate and is shaped to conform to the shape of said head portion to ensure absolute parallelity of said vertical portion (21) with said - connector plate, and wherein said vertical portion is provided with one obliquely directed bore (26) coaxially aligned with said screw-theaded bore (5) in said connector plate, and with at least two straight bores (27) coaxially aligned with said at least two straight bores (7) in said plate,

a tubular guide (31) of an outer diameter cooperating with said oblique bore in said connector arm ard of an inner diameter corresponding to the outer diameter of said sleeve covering said long screw, of a length compatible with the distance between the respective oblique bores in said plate and said arm,

a first removable tube (32) for insertion into said tubular guide of an inner diameter corresponding to the outer diameter of a guide wire (30) to be pushed therehrough into said fractured bone,

a second removable tube for insertion into said tubular guide of an inner diameter corresponding to the diameter of a drill for pre-drilling said bone,

a guide wire (30) to be pushed through the bore in said first removable tube,

a drill to be inserted into the bone material through the bore in said second removable tube,

a tubular guide for insertion into said straight bores (27) in said connector arm, of a length compatible with the distance to said connector plate, and of an inner diameter suitable for the passage of a drill destined for pre-drilling the bone for acceptance of said shorter screws (33),

a screw-driver (V) for insertion and fixation of said long screw composed of an inner shaft (40) prcvided with a screw-threaded inner end (41) for engagement with said screw-threaded bore (13) in the recessed end of said long screw, of a median tubular shaft (43) provided with a

polygonal inner end (44) for engagement with said polygonal recess (12) in said long screw. and of an outer tubular shaft (47) provided at its inner end with protruding teeth (48) for engagement with said recesses (16) in said sleeve covering said long screw, wherein all three shafts are independently movable in both axial and rotational direction by grips (42,45,49) attached to their outer ends, and wherein helical springs (50,51) are provided serving to adjust the axial alignment of the respective shafts.

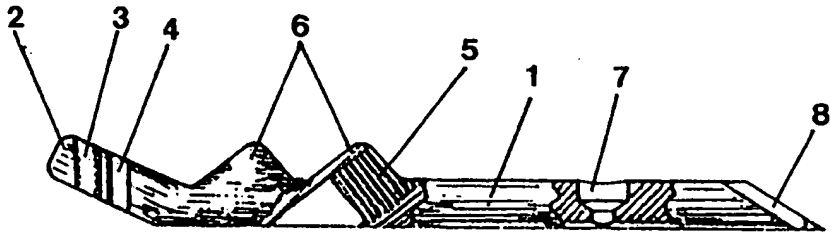

FIG. 1

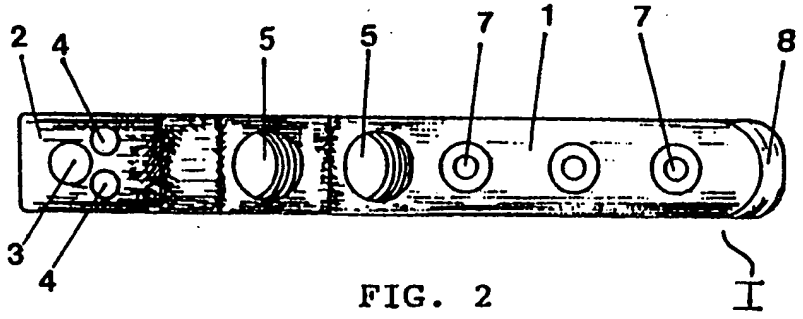

FIG. 2

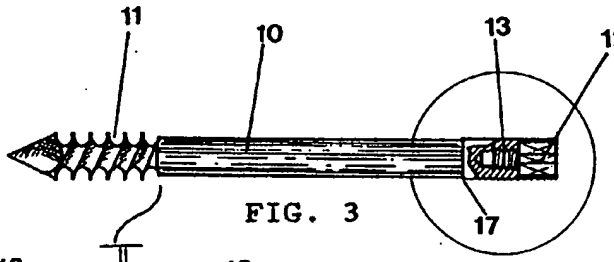

FIG. 3

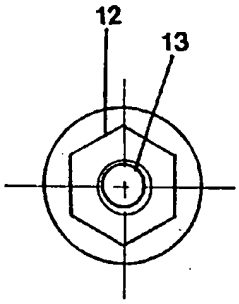

FIG. 5

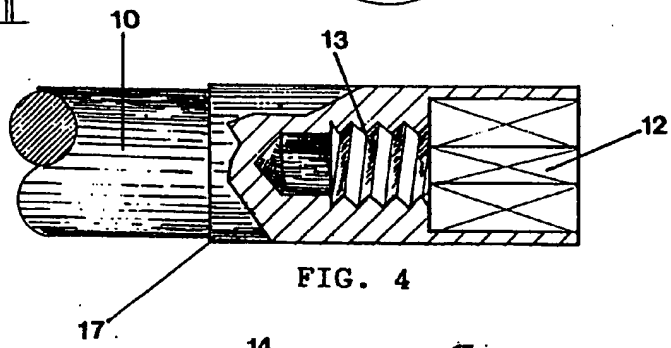

FIG. 4

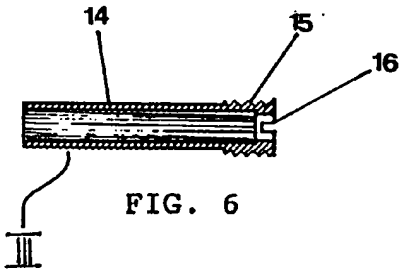

FIG. 6

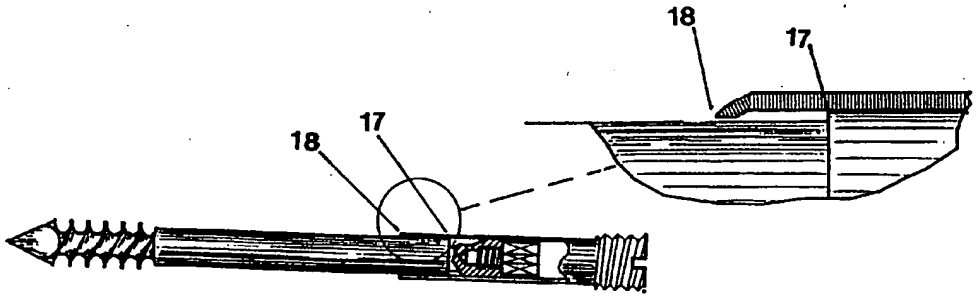

FIG. 7

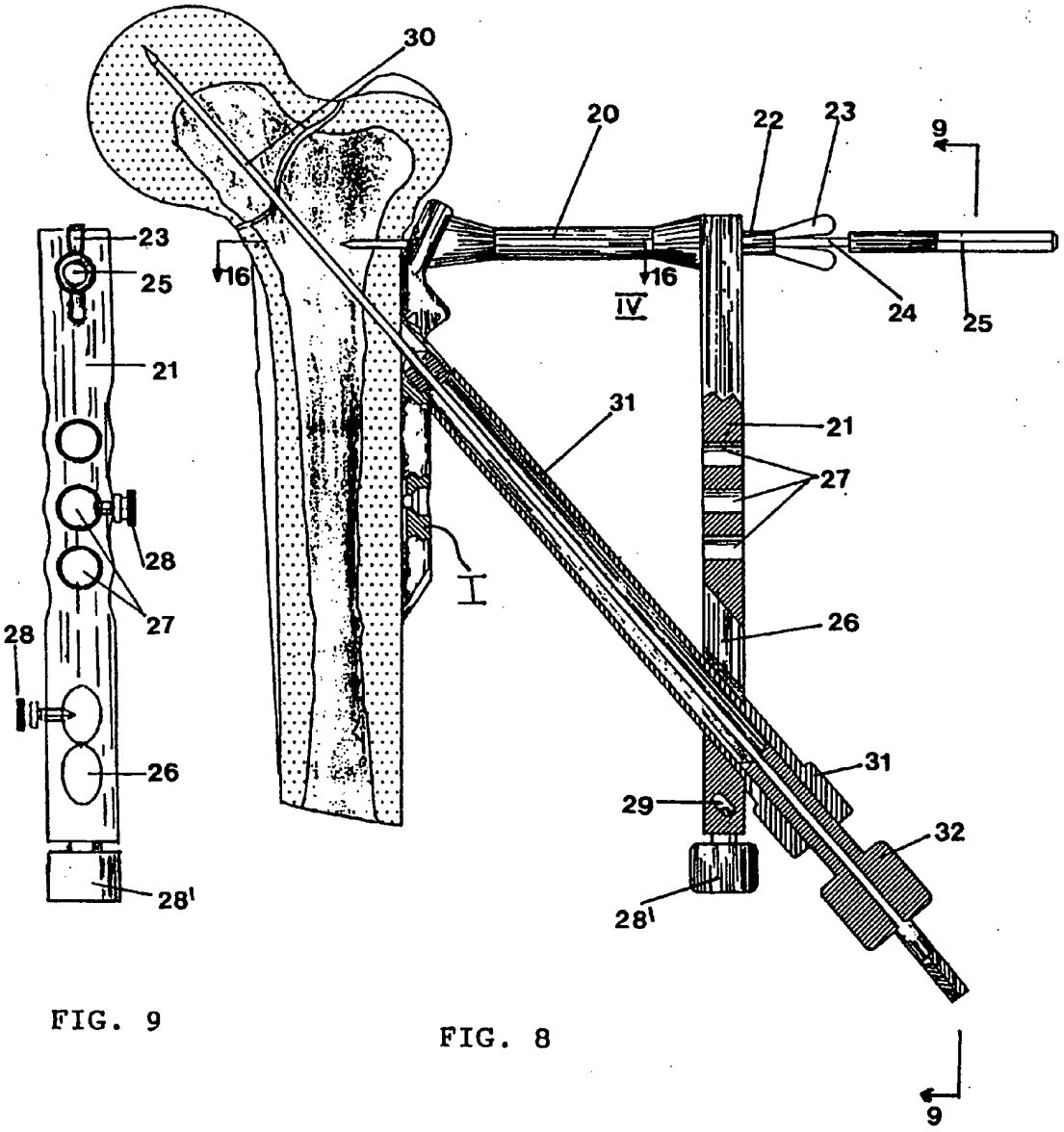
30
20
22
23
9
16
16
IV
24
25
23
25
21
31
21
27
28
I
27
26
28
26
31
29
32
28'
28'
9

FIG. 9

FIG. 8

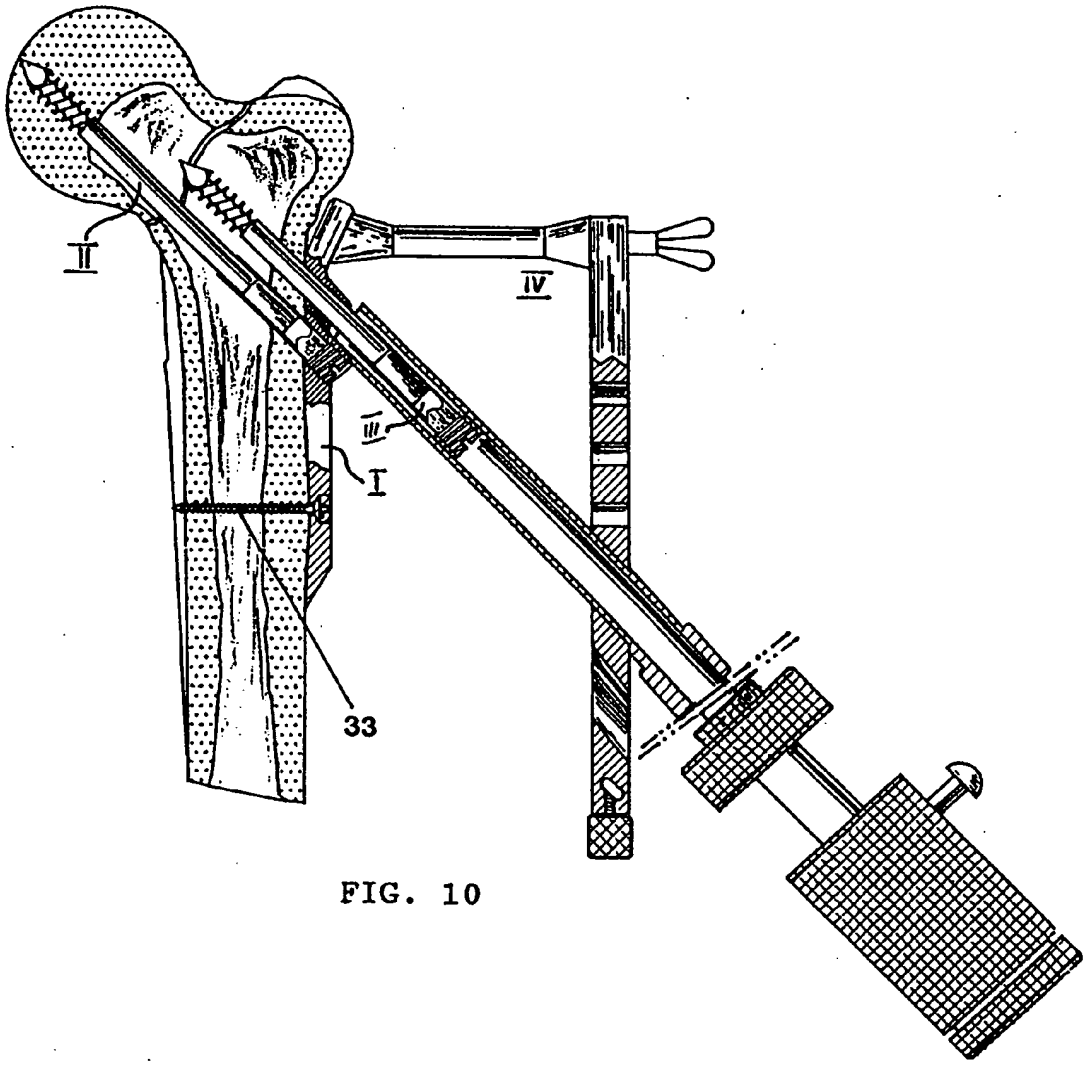

FIG. 10

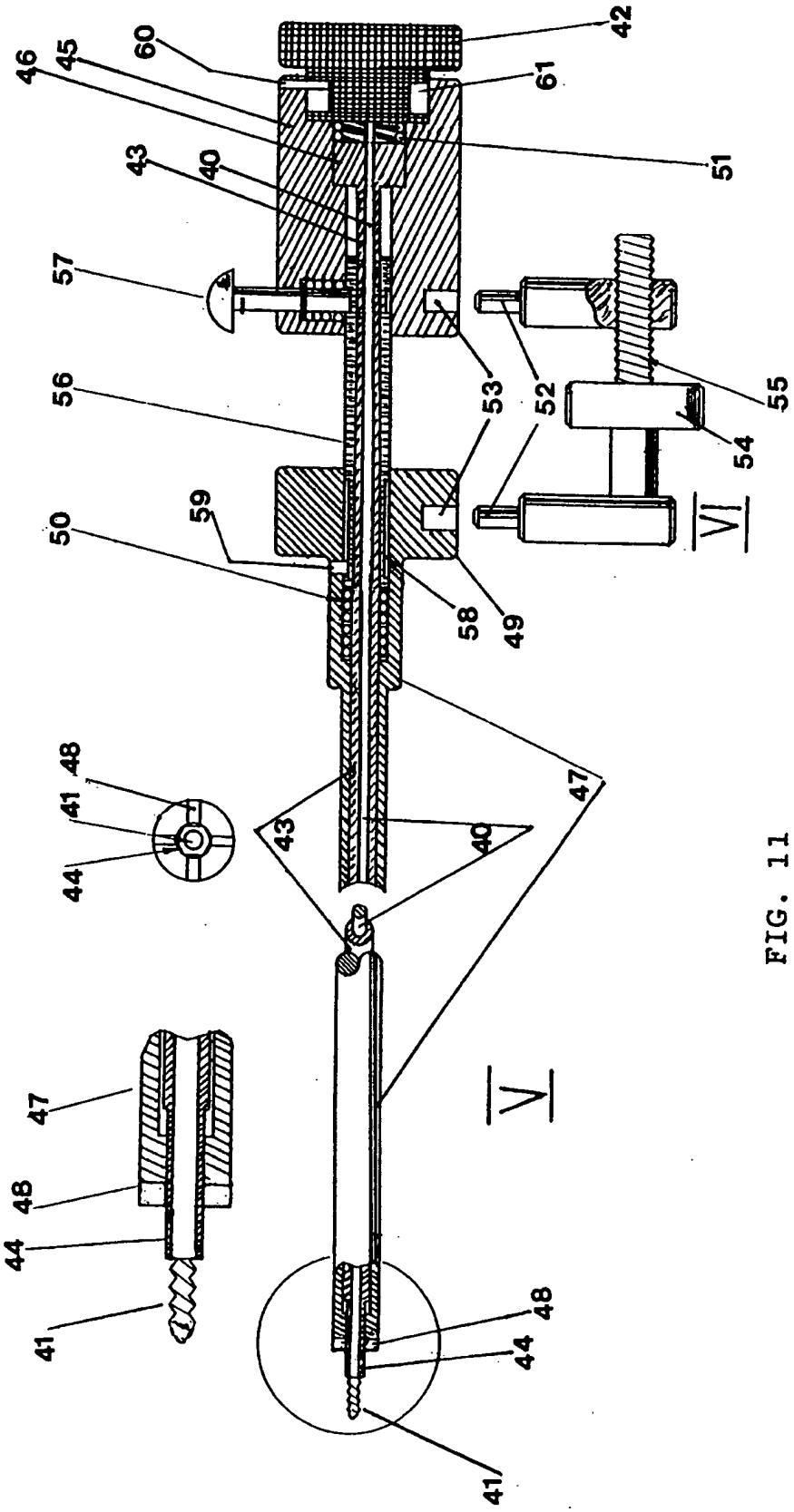
42
60
46
45
61
51
43
40
57
53
52
55
56
54
VI
59
50
58
49
48
41
47
44
43
40
V
47
48
44
41
48
44
41

FIG. 11

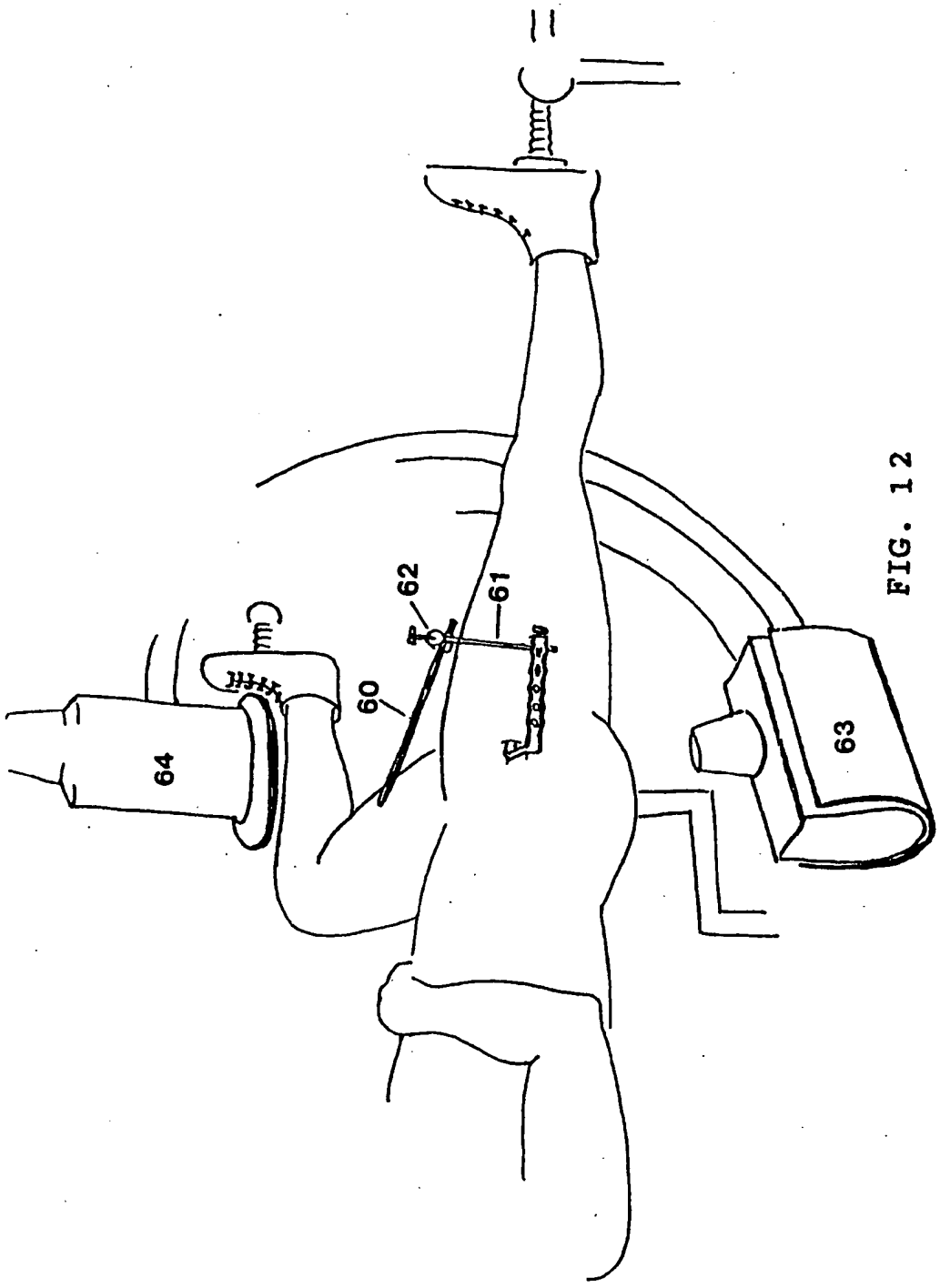

FIG. 12

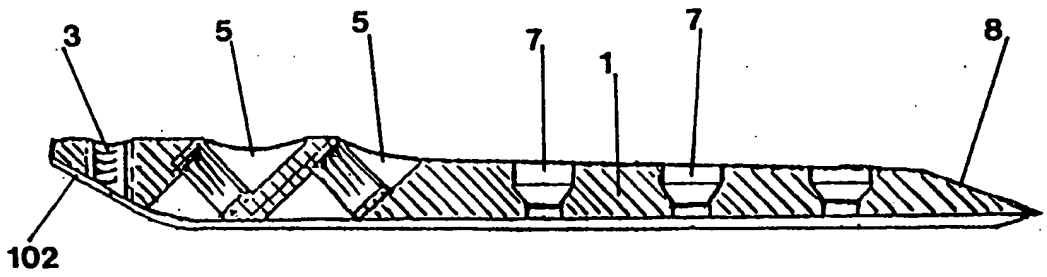

FIG. 13

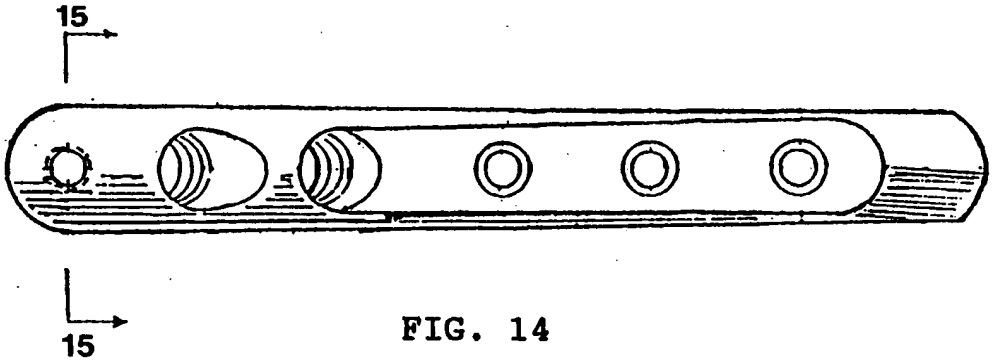

FIG. 14

FIG. 15

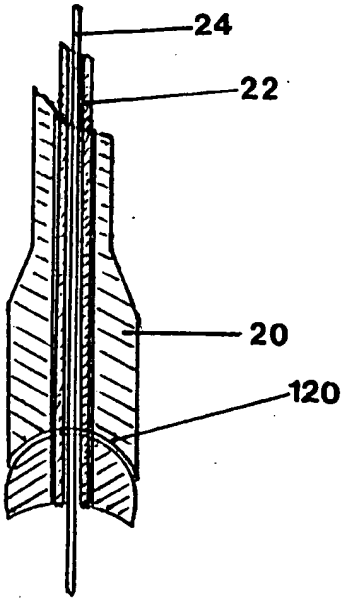

FIG. 16

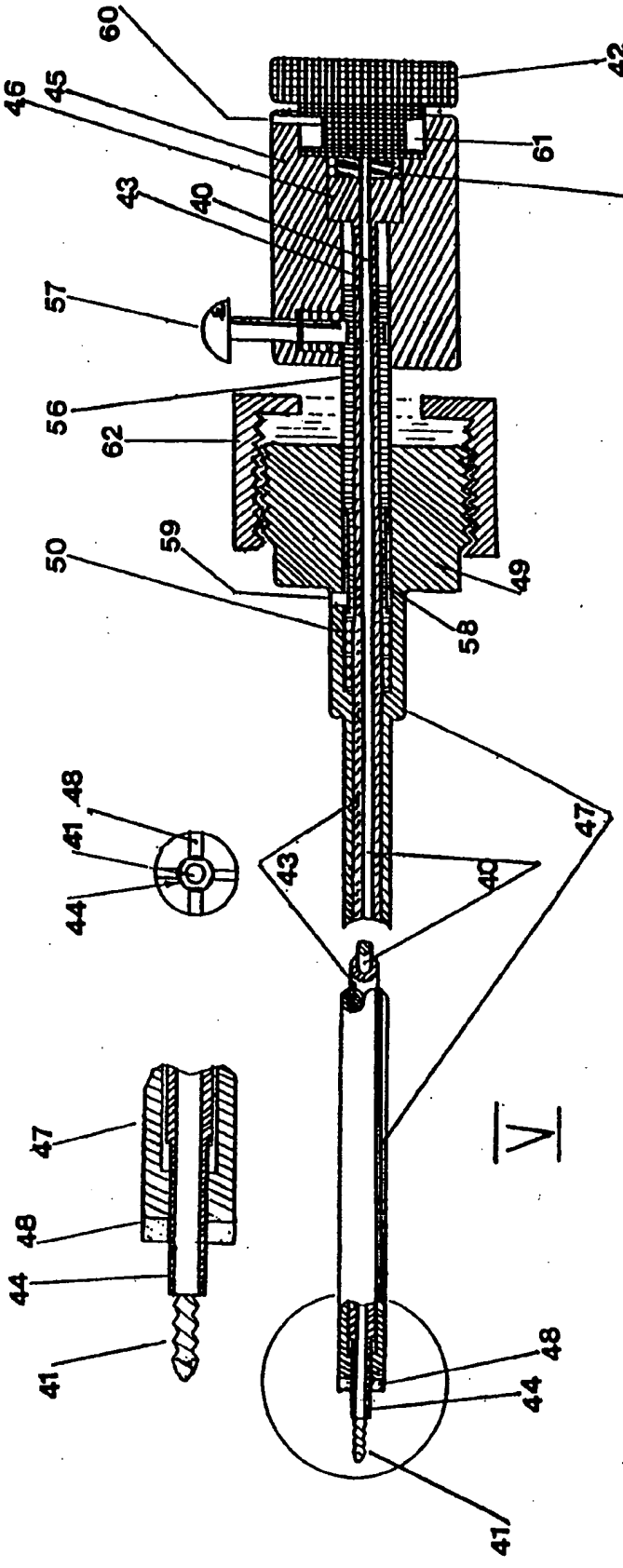
60
42
46
45
61
51
43
40
57
56
62
59
50
49
58
48
41
44
47
V
V
47
48
44
41
48
44
41

FIG. 17

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 94 30 2143

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
A,D	US-A-4 465 065 (GOTFRIED) * claim 1; figures 4,5 *	1,2,17, 18	A61B17/58
A	US-A-2 834 342 (CLYDE) * column 2, line 7 - line 8; figure 1 *	1,17	
A	EP-A-0 217 317 (VON HASSELBACH) * page 6, line 25 - line 27; figure 1 *	1,17	
A	EP-A-0 441 577 (SMITH & NEPHEW RICHARDS) * column 4, line 39 - line 56; figures 1,3,5 *	1,17	
A	EP-A-0 085 493 (RICHARDS) * page 5, line 27 - page 6, line 23; figures 1,20 *	1,17	
A	EP-A-0 377 401 (MECRON) * column 3, line 7 - line 12; figure 1 *	1,17	TECHNICAL FIELDS SEARCHED (Int.Cl.5)
A	WO-A-89 06940 (BIOMET) * abstract; figures 1,2 *	1,17	A61B
A	WO-A-92 15257 (HOWMEDICA) * page 7, line 17 - page 8, line 20; figures 5-7 *	2,18	
A	EP-A-0 251 583 (PFIZER) * column 16, line 47 - column 17, line 35; figures 18,3-5 *	2,18	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	27 June 1994	Moers, R

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 617 927 B1

(12) EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the grant of the patent:
20.01.1999 Bulletin 1999/03

(51) Int. Cl.[6]: **A61B 17/58**

(21) Application number: **94302143.6**

(22) Date of filing: **24.03.1994**

(54) Surgical device for connection of fractured bones

Chirurgische Vorrichtung zur Verbindung von Knochenbrüchen

Dispositif chirurgical pour assemblage de morceaux dos fracturés

(84) Designated Contracting States:
CH DE ES FR GB IT LI

(30) Priority: **28.03.1993 IL 10518393**

(43) Date of publication of application:
05.10.1994 Bulletin 1994/40

(73) Proprietor: **Gotfried, Yehiel**
Kiryat-Bialik (IL)

(72) Inventor: **Gotfried, Yehiel**
Kiryat-Bialik (IL)

(74) Representative:
Clifford, Frederick Alan
MARKS & CLERK,
57/60 Lincoln's Inn Fields
London WC2A 3LS (GB)

(56) References cited:
EP-A- 0 085 493
EP-A- 0 217 317
EP-A- 0 251 583
EP-A- 0 377 401
EP-A- 0 441 577
WO-A-89/06940
WO-A-92/15257
US-A- 2 834 342
US-A- 4 465 065

Note: Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

EP 0 617 927 B1

Printed by Xerox (UK) Business Services
2.16.7/3.6

Description

BACKGROUND OF THE INVENTION

The present invention is an improvement of the surgical device disclosed in my U.S. Patent No. 4,465,065. It serves for connection of the fractured neck to the shaft of a femur by means of a pre-drilled connector plate, without the requirement of making a large incision in the overlying skin and tissue.

The connector plate according to the above patent and according to the present invention has a sharp lower edge by which it penetrates through a small incision in the trochanter region into close contact with the shaft. During the operation the plate is temporarily attached to the horizontal portion of a connector arm, while its vertical portion extends parallel to the plate and is provided with holes which are coaxial with the holes in the plate. Concentric guide tubes are inserted through the holes in the vertical portion of the connector arm, are pushed through the soft tissue up to the plate and serve as guides for pre-drilling of the bone parts in the correct position as viewed by X-ray equipment. After pre-drilling the inner guide tubes are removed and the outer tubes serve for insertion of long screws, and are afterwards removed. The long screws are tightened so as to contract the fractured parts. Short screws serving for firm attachment of the plate to the femur shaft are now inserted through the vertical portion of the connector arm, after suitable drilling through tubes inserted into holes in the arm, which are co-axial with the holes in the plate. The connector arm is now detached from the plate, and the wound is closed. The present device is similar and serves the same purpose, but is designed to avoid certain drawbacks of the original device which have come to light during its use in operations of the kind referred to. The following main drawbacks were observed:

The long screws did not permit active compression of the fractured bone parts, a task which is most important for quick healing of the bone and for early use of the limb by the patient.

The long screws were not sufficiently guided in the holes of the connector plate and were apt to wobble, often resulting in instability of the fracture after connection.

The screws were apt to protrude out of the bone into the soft tissue, after walking of the patient had started and the fracture had been pressed.

The connector plate was not firmly fastened to the femur during operation, which made drilling difficult.

The device according to the present invention aims to obviate these drawbacks by providing improved components which facilitate and shorten the progress of the operation on the one hand, and hold the fractured parts in full alignment and under compression after their complete jointing, on the other. In addition, sufficient space is provided for axial sliding out of the connecting screws, while preventing their protrusion out of the connector plate.

SUMMARY OF THE INVENTION

Before going into constructional details of the device,it should be noted that the following directional expressions will be employed in respect of the femur bone, the tool, the connector plate and the screws during the operation:-

> the expressions "top" and "upper portion" of any part will refer to the femur top, and the "bottom" or "lower" portion" will refer to the direction towards the knee joint. The expression "inside" or "inner portion" will refer to parts close to the bone outside or pointing towards it, while the expression "outside" or "outer portion" will refer to those parts which are outside the human body operated on, or pointing away from the bone.

The improved surgical device for percutaneous connection of a fractured upper part of the femur to the femur shaft, the device including the following components to remain in the body:-

> a bar-shaped connector plate having an inner surface to be placed onto the bone, an outer surface, a head portion and a bottom provided with a sharpened end for its insertion through a small incision in the skin, said connector plate being provided in its lower portion with at least two countersunk, through-going bores and in its upper portion with one or two oblique bores of larger diameter directed in upward direction at an angle of about 130°, a screw-threaded bore perpendicular to the axis of said bar-shaped connector being provided in said head portion;
> one or two long screws and one or two sleeves, each of said one or two long screws having a straight shaft, a wood-screw-shaped inner end for insertion into said fractured bone part and an outer end coaxially recessed in hexagonal or other polygonal shape, said recess being continued by a screw-threaded bore concentric with said shaft axis, the outer end portion of each said screw being positioned and movable in both axial and rotational direction in a sleeve, wherein each of said one or two sleeves are of shorter length than said one or two screws, the outer end of each sleeve being provided with at least two recesses for engagement of a screwdriver;
> and each of said oblique bores are screw-threaded and the outer end of each sleeve being provided with screw-thread corresponding to the screw-thread in said oblique bore in said connector plate, each of said long screws is provided with a circumferential step, and wherein the inner end of each

sleeve is inwardly crimped, to prevent said screw from sliding out of said sleeve, owing to contact of said step with said crimped end, and the device further including at least two shorter screws for securing said connector plate to the femur shaft, extending through said straight bores into the bone material.

A combination of a surgical device as mentioned above and an auxiliary equipment serving to insert and to connect said surgical device to a fractured bone the auxiliary equipment comprising:

an angular connector arm including a short horizontal portion for connection to the head portion of said connector plate and a longer vertical portion extending parallel to the straight lower portion of said plate, wherein said horizontal portion is provided with an axial perforation for passage of a screw engaging with said screw-threaded bore in said head portion of said plate and is shaped to conform to the shape of said head portion to ensure absolute parallelity of said vertical portion with said connector plate, and wherein said vertical portion is provided with one or two adjoining obliquely directed bores coaxially aligned with said one or two screw-threaded bores in said connector plate, and with at least two straight bores coaxially aligned with said at least two straight bores in said plate;
a first tubular guide of an outer diameter cooperating with said one or two oblique bores in said connector arm, and of an inner diameter corresponding to the outer diameter of said one or two sleeves covering said one or two long screws, of a length compatible with the distance between the respective oblique bores in said plate and said arm;
a first removable tube for insertion into said tubular guide and to be screwed into said oblique bore in said connector plate, of an inner diameter corresponding to the outer diameter of a guide wire to be pushed there-through into said fractured bone;
a second removable tube for insertion into said tubular guide and to be screwed into said oblique bore in said connector plate, of an inner diameter corresponding to the diameter of a drill for pre-drilling said bone;
a guide wire to be pushed through the bore in said first removable tube;
a drill to be inserted into the bone material through the bore in said second removable tube;
a second shorter tubular guide for insertion into said straight bores in said connector arm, of a length compatible with the distance to said connector plate, and of an inner diameter suitable for the passage of a drill destined for pre-drilling the bone for acceptance of said shorter screws;
a screw-driver for insertion and fixation of said one or two long screws composed of an inner shaft provided with a screw-threaded inner end for engagement with said screw-threaded bore in the recessed end of each one or two long screws, of a median tubular shaft provided with a polygonal inner end for engagement with said polygonal recess in each long screw and of an outer tubular shaft provided at its inner end with protruding teeth for engagement with said recesses in said one or two sleeves covering said one or two long screws, wherein all three shafts are independently movable in both axial and rotational direction by grips attached to their outer ends, and wherein helical springs are provided serving to adjust the axial alignment of the respective shafts.

The auxiliary equipment is removed from the body after the connector plate has been firmly connected to the femur shaft id the fracture has been connected and duly compressed by means of the long screws, whereafter the wounds are to be dressed.

The operation is carried out as described before in connection with the device disclosed in US 4,465,065, with the difference that according to the present invention the long screws are axially movable, both active and passive, in their respective sleeves which have their screw-threaded ends firmly connected to the bores in the connector plate. This feature permits active compression of the fractured parts by the surgeon and preventing the drawback of the previous invention of gradual protrusion of the screw heads into the soft tissue with subsequent irritation and pains. In addition, the improved auxiliary equipment according to the present invention not only facilitates the operation, but requires less time than before, a boon both for the patient and the surgeon.

The manner and sequence of operating on a fractured femur neck will be described in detail with reference to the drawings showing the various permanent and auxilary components of the device.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a side view and part section of the connector plate,
Figure 2 is a plan view of the connector plate illustrated in Figure 1,
Figure 3 is a side view of a long screw,
Figure 4 is a section through the outer end of the screw illustrated in Figure 3,
Figure 5 is an end view of the screw illustrated in Figure 3,
Figure 6 is a longitudinal section of the sleeve covering the outer end of the long screw,
Figure 7 is a side view and part section of the long screw positioned in the sleeve of Figure 6,
Figure 8 is a sectional view of the connector plate, the connector arm and auxiliary equipment at the

beginning of an operation,

Figure 9 is an end view of the connector arm along line 9-9,

Figure 10 is a sectional view of the connector plate, the connector arm, and the screwdriver, showing an advanced state of the operation, with one long screw and sleeve in position and a second screw in its way to its final position,

Figure 11 is a longitudinal section through the screwdriver used in inserting the long screws and their sleeves,

Figure 12 is a drawing showing a stage of the operation while using a rod-shaped aiming device,

Figure 13 is a side view and part section of a second embodiment of the connector plate,

Figure 14 is a plan view of the connector plate illustrated in Figure 13,

Figure 15 is a section along line 15-15 of Figure 14,

Figure 16 is a section along line 16-16 of Figure 8, showing connection of the connector plate of Figure 13 to the connector arm, and

Figure 17 is a longitudinal section of another embodiment of the screwdriver illustrated in Figure 11.

DETAILED DESCRIPTION OF THE DRAWINGS

The connector plate I illustrated in Figures 1 and 2 includes a straight lower, main portion 1 and a head portion 2 outwardly bent in respect of the main portion, to conform to the contour of the bone. The head portion contains one larger, screw-threaed bore 3 and two smaller bores 4 for connection to the horizontal portion of the connector arm as will be described in detail further on. Next to the head portion two obliquely directed, screw-threaded bores 5 penetrate the main portion at an angle of about 130°, the outer surface of the portion being thickened by two lugs 6 permitting a greater length of the bores 5. Underneath the two bores 5 three countersunk bores 7 are drilled through the main portion at right angles thereto. The lower end of the main portion is sharpened (8) having the purpose of penetrating through the soft tissue and muscles close to the femur shaft during its insertion through a small out in the skin.

One of the two long screws II and its sleeve III is illustrated in Figures 3 through 7:- Herein the screw includes a relatively long shaft 10, an inner end provided with screw thread 11 similar to that provided on wood screws, and an outer end recessed in the form of a hexagon 12 continued with a screw-threaded bore 13 of smaller diameter. The outer end of the screw is slidably, but tightly, inserted into the inner bore of a sleeve 14, which has its outer end provided with outside screw thread 15 and slotted by two or four slots 16 serving to engage the special screw driver to be shown in Figure 11. The assenbled screw and sleeve are shown in Figure 7, part in side view and part in section. The inner end of the sleeve is inwardly crimped (18), thereby preventing the screw from sliding out of the sleeve by contact with a step 17 on the screw shaft. The three screws connecting the plate to the shaft of the femur by means of the three bores 7, are not shown as of the usual kind and size used in similar operations.

Figures 8, 9 and 10 illustrate the auxiliary equipment serving for insertion and tightening of the long screws and for compressing the fractured bone parts after insertion of the screws. The main instrument is an L-shaped connector arm IV which includes a horizontal portion 20 and a vertical portion 21 firmly connected to each other at right angles. The horizontal portion is provided at its inner end with two pins (not visible) engaging the bores 4 of the connector plate and serving to ensure exact parallel alignment of the connector plate with the vertical portion. A connecting screw 22 extends through a central bore in the horizontal portion and connects the connector arm to the plate by engaging the screw thread 3 in the latter, being actuated by a grip 23. At the same time two pins enter the bores 4 and prevent relative rotation of connector plate and arm. The screw 22 is hollow to permit passage of a long, pointed bar 24 provided with a grip 25 for forceful insertion into the bone and for exact location of both the connector plate and the connector arm.relative to the femur bone. The vertical portion contains two large, obliquely directed bores 26 which are coaxially aligned with the bores 5 in the connector plate, but of larger diameter. Above the two bores 26, three smaller bores 27 are drilled through the portion at right angles thereto and coaxially aligned with the bores 7 of the connector plate. Set screws 28 penetrate the sides of the bores 26 and 27 and serve to hold the tubular guides in position.An additional feature of the connector arm is in the form of an oblong hole 29 perforating the lower end of the vertical portion and adapted to hold a rod-shaped aiming device which is secured by a set screw 28'. Figure 12 shows the aiming device in position, as well as the X-ray equipment positioned above and below the fracture to be connected.

Figure 8 likewise illustrates a first stage of an operation carried out by means of the device: after the connector plate has been inserted into the thigh through a small cut and has been slid into an approximate position as viewed by means of X-ray equipment and the aiming device; its correct location in relation to the neck portion is found by means of a guide wire 30 which is inserted into the bone material of the femur shaft and into the bone of the neck through an inner tubular guide (32) located within an outer tube 31 extending through the bore 26 of the connector arm into the screw-threaded bore 5 of the connector plate. The inner tubular guide 32 is screwed into bore 5 of the plate in order to permit exact centering of guide wire 30 and to prevent its disengagement from the connector plate. In case of incorrect location the guide wire is withdrawn, the connector plate is moved by means of the connector arm into another position and the guide wire is again inserted

into the bone. In the case the location is found to be correct as seen by X-ray viewing, the pointed bar 24 is forcefully pushed into the bone to finally fix the position of bone and plate, whereupon the guide wire 30 and the inner tubular guide (32) are removed. They are replaced by the second inner tubular guide of wider inner bore, and a drill is inserted therethrough which, by mechanical rotation, drills holes into the shaft and the neck for subsequent insertion of one of the long screws.

The special screwdriver V as illustrated in Figure 11 comprises three concentrically aligned shafts which are independently movable in both axial and rotary direction. They include:

1. an innermost shaft 40 with a screw-threaded end 41 suitable for engaging the bore 13 in the rear end of the long screws and for rotation by a grip 42 at the outer end of the screw driver.
2. an inner tubular shaft 43 having a hexagon-shaped end 44 for engagement with the hexagonal recess 12 in the long screws. It can be rotated for driving the screw into the pre-drilled bone material by means of a cylindrical grip 45 via a disc 46 firmly mounted on the shaft 43.
3. An outermost tubular shaft 47 having an inner end in the form of cross-wise aligned edges 48 for engagement with slots 16 in the screw sleeves III. It can be rotated for the purpose of screwing the sleeves into the connector plate by means of a cylindrical grip 49.
4. An outer sleeve 56 rotationally and longitudinally movable on the inner movable shaft 43. It is provided with a circumferential recess 58 engaged by a pin 59 serving to limit the longitudinal motion of the shaft. A seconnd circumferential recess is provided at the other end of sleeve 56e and engages a stop 57.

The components can be axially moved relative to each other, but are urged into their normal position by helical springs 50 and 51, while additional axial motion of the tubular shaft 43 is made possible by withdrawal of stop 57; their specific use will be explained further on in connection with the final stage of the operation.

The final stage of the operation of connecting a fractured head to the femur shaft is illustrated in Figure 10, as follows:-

After the bone has been drilled through the oblique bores the inner tubular guide is removed. Now the two long screw-and-sleeve assemblies are inserted and fastened, one after the other, with the aid of the screw driver V, as follows:- a screw II is pulled back into a sleeve III up to its outer end, and the hexagon-shaped end 44 of the screwdriver is pushed into the correspondingly shaped recess 12 in the screw end. By rotating grip 42 and pushing it against the force of helical spring 51, the threaded end 41 of the innermost shaft 40 of the screwdriver is screwed into screw-threaded bore 13 of the screw, while the protruding edges 48 of the outermost tubular shaft 47 are urged into slots 16 in the end of sleeve III by means of helical spring 50. Additional tightening of the screwed end 41 into bore 13 connects and firmly secures the screw-and-sleeve assembly to the screwdriver. By means of the screwdriver the assembly is now pushed in inward direction through the outer tubular guide 31, and rotated as far as the screw-thread on the sleeve III allows, and the sleeve is screwed into bore 5 of the connector plate by rotation of grip 49. By pulling out the stop 57, grip 45 which is connected to the inner shaft 43 by means of collar 46, can be moved in inward direction thereby pushing shaft 43 inwardly. By rotating and pushing grip 45 inwardly, screw II is moved along sleeve III and is urged towards the fractured head portion and inserted into the pre-drilled bore in the bone material, rotation being stopped as soon as it has reached the required depth as viewed by X-ray equipment, or whenever step 17 on the screw has reached the crimped end 18 of the sleeve. A pin 60 engaging with a circumferential groove 61 limits the distance to which grip 42 can be moved in outward direction, while being urged there by spring 51. In addition, during fracture compression pin 60 transfers the load from grip 45 to shaft 40 via grip 42. In order to pull the fractured head in direction of the femur shaft and thus to compress the fracture, a retracting device VI is attached to the grips 45 and 49 by means of pins 52 inserted into corresponding holes 53. By rotating the handwheel 54, screw 55 pulls grips 49 and 45 apart as well as grip 42 (by means of pin 60),thereby pulling the attached screw I into the sleeve which is firmly screwed and secured in the plate. After insertion and fixation of the first screw, pointed bar 24 is removed and the second screw is inserted into the fractured parts in the same manner.

After insertion of both long screws, the connector plate is firmly attached to the femur shaft by means of two to three shorter screws. For this purpose a shorter tubular guide is inserted into the tissue through one of the bores 27 of the connector arm and secured by a set screw 28. Thereafter the bore is drilled in the conventional manner and a screw 33 is inserted with its head positioned in the countersink of the bore 7, preventing its protruding out of the plate. After all screws have been fixed, the connector arm is removed from the plate and out of the body by detaching screw 22, the skin incisions are closed and the wounds are dressed.

Figures 13, 14, 15 and 16 show a simplified version of the connector plate illustrated in Figures 1 and 2.It differs from the earlier version by omission of the outwarrdly bent head portion 2, the two small bores 4 and of the two lugs 6, the other components being identical in both embodimerts and marked by identical numerals. The present connector plate has a thicker upper portion, while the lower portion is of about the same thickness as that shown in Figure 1. Instead of the bent head portion the underside of the thickened upper portion is cut away at a slant (102) corresponding to the shape of the

femur. The two lugs 6 appearing in Figure 1 are necessarry to permit a sufficient length of the screw thread 5, but owing to the greater thickness of the present plate there is sufficient material for these bores. The two bores 4 of Figure 1 are necessary for connection to the connector arm by means of two pins engaging with the bores; the present connection is made by engagement of the concave end of the arm (120) with the rounded top surface of the connector plate (v.Figure 15), thus keeping the two in firm and straight alignment.

A second version of the screwdriver V is illustrated in Figure 17, wherein the means for moving the grips 49 and 45 apart is by means of a cup-shaped spacer 62. The spacer is provided with inner screwthread cooperating with outer screwthread on grip 49. By rotation of the spacer it is moved to the rear until it contacts grip 45 and moves grip 42 via pin 60 to the rear, thereby pulling screw II rearwardly into the sleeve by means of screw 41 engaging the tapped bore 13 in the screw end, and thus compresses the fracture.

Figure 12 illustrates the shape and use of an aiming device which is an additional feature of the invention. The device is used at the beginning of the operation to locate the optimal final position of the screws to be inserted into the fractured bone. It is attached to the connector arm 21 and is adjusted in the direction of the fracture from the outside of the thigh. By viewing the position of the aiming device in relation to the femoral neck by X-ray equipment (63,64) the position of the connector plate and the auxiliary equipment can be adjusted and brought into the most suitable location.

The aiming device comprises an aiming rod 60 connected to the end of a connecting bar 61 at right angles by clamping means 62. The connecting bar is held in position in the hole 29 at the bottom end of the connector arm 21 and secured there by means of the set screw 28'. After adjustment of the connector plate the aiming device can be detached. As known to the art, all further stages of the operation are likewise controlled by X-ray viewing.

It is reiterated that a few of the described stages of the afore described percutaneous operation are resemble those described in my United States Patent No. 4,465,065, but that most components of the present device have been changed and modified. The improvements over the surgical device described in my earlier patent are:- fixation of the long screws in sleeves, permitting their axial sliding motion without protrusion out of the bone and soft tissue; ready insertion of the long screws by means of special tooling, and active compressing of the fracture after insertion of the long screws, again with the aid of the special screwdriver. In addition, modification of the connector plate enhances stability of the junction between plate and screw, while the temporary fixation of the plate to the femur by means of the pointed bar 24 ensures high accuracy in pre-drilling of the bone.

In case only one long screw is to be inserted into the fractured bone, only one of the olique bores (5) in the connector plate and one of the bores (26) in the connector arm will be used or, alternatively, both the connector plate and the connector arm are provided with one oblique bore only. In the latter case, a bolt of somewhat larger diameter may be used together with a correspondingly larger sleeve and larger bores in the device components.

It will be understood that the outer shape and form of the different components, both permanent and auxiliary, have been designed with the object of performing the task in hand at maximum convenience for the surgeon and in a mimimum of time, by obviating change of tools and equipment as found necessary with conventional devices. However, they may be changed or modified as long as they will serve to perform the afore described steps of the operation, i.e. connecting and compressing the fractured parts for the benefit of the patient, while maintaining the percutaneous surgical technique.

Claims

1. A surgical device for percutaneous connection of a fractured upper part of the femur to the femur shaft, the device including the following components to remain in the body:-

   a bar-shaped connector plate (I) having an inner surface to be placed onto the bone, an outer surface, a head portion and a bottom provided with a sharpened end (8) for its insertion through a small incision in the skin, said connector plate being provided in its lower portion with at least two countersunk, through-going bores (7) and in its upper portion with one or two oblique bores (5) of larger diameter directed in upward direction at an angle of about 130°, a screw-threaded bore (3) perpendicular to the axis of said bar-shaped connector being provided in said head portion;
   one or two long screws (II) and one or two sleeves (III), each of said one or two long screws (II) having a straight shaft (10), a wood-screw-shaped inner end (11) for insertion into said fractured bone part and an outer end, the outer end portion of each said screw being positioned and movable in both axial and rotational direction in sleeve (III),
   characterised in that, said one or two sleeves (III) are of shorter length than said one or two long screws (II), the outer end of each long screw (II) being coaxially recessed (12) in hexagonal or other polygonal shape, said recess being continued by a screw-threaded bore (13) concentric with said shaft axis, the outer end of each sleeve (III) being provide with at least two recesses (16) for engagement of a screwdriver,

and each of said oblique bores (5) are screw-threaded and the outer end of each sleeve being provided with screw-thread (15) corresponding to the screw-thread in said oblique bore in said connector plate, each of said long screws (II) is provided with a circumferential step (17), and wherein the inner end (18) of each sleeve is inwardly crimped, to prevent said screw from sliding out of said sleeve, owing to contact of said step with said crimped end, and the device further including at least two shorter screws (33) for securing said connector plate (I) to the femur shaft, extending through said straight bores (7) into the bone material.

2. A combination of a surgical device as defined in claim 1 and an auxiliary equipment serving to insert and to connect said surgical device to a fractured bone the auxiliary equipment comprising:

an angular connector arm (IV) including a short horizontal portion (20) for connection to the head portion of said connector plate and a longer vertical portion (21) extending parallel to the straight lower portion of said plate, wherein said horizontal portion is provided with an axial perforation for passage of a screw (22) engaging with said screw-threaded bore (3) in said head portion of said plate and is shaped to conform to the shape of said head portion to ensure absolute parallelity of said vertical portion (21) with said connector plate, and wherein said vertical portion is provided with one or two adjoining obliquely directed bores (26) coaxially aligned with said one or two screw-threaded bores (5) in said connector plate, and with at least two straight bores (27) coaxially aligned with said at least two straight bores (7) in said plate;

a first tubular guide (31) of an outer diameter cooperating with said one or two oblique bores (26) in said connector arm, and of an inner diameter corresponding to the outer diameter of said one or two sleeves covering said one or two long screws, of a length compatible with the distance between the respective oblique bores in said plate and said arm;

a first removable tube (32) for insertion into said tubular guide and to be screwed into said oblique bore in said connector plate, of a inner diameter corresponding to the outer diameter of a guide wire (30) to be pushed there-through into said fractured bone;

a second removable tube for insertion into said tubular guide and to be screwed into said oblique bore in said connector plate, of an inner diameter corresponding to the diameter of a drill for pre-drilling said bone;

a guide wire (30) to be pushed through the bore in said first removable tube;

a drill to be inserted into the bone material through the bore in said second removable tube;

a second shorter tubular guide for insertion into said straight bores (27) in said connector arm, of a length compatible with the distance to said connector plate, and of an inner diameter suitable for the passage of a drill destined for pre-drilling the bone for acceptance of said shorter screws (33);

a screw-driver (V) for insertion and fixation of said one or two long screws composed of an inner shaft (40) provided with a screw-threaded inner end (41) for engagement with said screw-threaded bore (13) in the recessed end of each one or two long screws, of a median tubular shaft (43) provided with a polygonal inner end (44) for engagement with said polygonal recess (12) in each long screw and of an outer tubular shaft (47) provided at its inner end with protruding teeth (48) for engagement with said recesses (16) in said one or two sleeves covering said one or two long screws, wherein all three shafts are independently movable in both axial and rotational direction by grips (42, 45, 49) attached to their outer ends, and wherein helical springs (50, 51) are provided serving to adjust the axial alignment of the respective shafts.

3. The surgical device as defined in claim 1, wherein said device comprises two adjoining oblique bores (5), two long screws (II) and two sleeves (III).

4. The combination of the auxiliary equipment as defined in claim 2 and the surgical device as defined in claim 3, wherein said vertical portion is provided with two adjoining obliquely directed bores (26) coaxially aligned with said two screw-threaded bores (5), and said auxiliary equipment comprises a pair of first tubular guides cooperating with said oblique bores in said connector arm.

5. The surgical device as defined in claim 3, wherein the outer portion of said connector plate surrounding said oblique screw-threaded bores is thickened in the form of two oblique lugs (6) protruding out of the plate surface.

6. The surgical device as defined in claim 3, wherein the head portion (2) of said connector plate (I) is bent outwardly to conform to the contour of the femur, and wherein said head portion is perforated by said screw-threaded bore (3) and by at least one smooth bore (4), both bores being perpendicular to

the axis of said connector plate.

7. The surgical device as defined in claim 3, wherein the inner surface of said head portion of said head portion of said connector plate slopes outwardly (102) in accordance with the contour of said femur.

8. The surgical device as defined in claim 3, wherein the outer surface of the head portion of said connector plate is convex.

9. The surgical device as defined in claim 4, wherein said vertical portion of said connector arm is provided with set screws (28) serving to secure said tubular guides.

10. The surgical device as defined in claim 4, wherein the inner end (120) of said horizontal portion of said connector arm is concave to correspond with the convex head portion of said connector plate.

11. The surgical device as defined in claim 4, wherein the lower end of the vertical portion of said connector arm is provided with means (28, 29) for holding a rod-shaped aiming device (60, 61, 62).

12. The surgical device as defined in claim 11, wherein said aiming device comprises an aiming rod (60) connected at right angles to a connecting bar (61), said connecting bar being adapted to be attached to the bottom end of said vertical portion of said connector arm by means permitting adjustment of the angular direction of said aiming bar.

13. The surgical device as defined in claim 4, wherein said screwdriver is provided with means for pulling the screw-threaded end (41) of said inner shaft (40) into said outer tubular shaft (47), serving to pull said long screw in outward direction relative to said sleeve.

14. The surgical device as defined in claim 4, wherein said screwdriver is provided with an outer sleeve (56) held in position by a removable pin (57) and engaging said outer tubular shaft (47) by means of a pin (59) movable along a circumferential recess (58) on the outside of said sleeve.

15. The surgical device as defined in claim 4, wherein said screw (22) extending through said horizontal portion of said connector arm is provided with a grip (23) at its outer end and is centrally perforated permitting the passage of a sharp pin or screw (25) to be pushed into the bone for exact fixation of said connector arm.

Patentansprüche

1. Chirurgische Vorrichtung zur perkutanen Verbindung eines gebrochenen oberen Teiles des Oberschenkelknochens mit dem Oberschenkelschaft, wobei die Vorrichtung die folgenden Komponenten einschließt, die dazu bestimmt sind im Körper zu bleiben:

   eine stabförmige Verbindungsplatte (I), mit einer inneren Oberfläche die auf den Knochen angeordnet wird, einer äußeren Oberfläche, einem Kopfteil und einem Fußteil, der mit einem zugespitzten Ende (8) versehen ist zwecks Einführung durch einen kleinen Einschnitt in der Haut, wobei die Verbindungsplatte in ihrem unteren Teil mit wenigstens zwei versenkten, durchgehenden Bohrungen (7) ausgestattet ist, und in ihrem oberen Teil mit einer oder mit zwei schrägen Bohrungen (5) mit einem größeren Durchmesser und unter einem Winkel von ungefähr 130° in Bezug auf die aufwärts verlaufende Richtung , wobei eine senkrecht zu der Achse des stabförmigen Verbindungsmittels verlaufende und mit einem Schraubengewinde versehene Bohrung (3) in dem Kopfteil vorgesehen ist;
   eine oder zwei lange Schrauben (II) und eine oder zwei Muffen (III), wobei eine jede unter den genannten eine oder zwei langen Schrauben (II) ausgestattet ist mit einem geraden Schaft (10), einem nach Art einer Holzschraube geformten inneren Ende (11) zur Einführung in den gebrochenen Teil des Knochens und einem äußeren Ende, wobei der Abschnitt am äußeren Ende einer jeden Schraube so in einer Muffe (III) angeordnet ist, daß er sowohl in der axialen Richtung als auch in der Umdrehungsrichtung beweglich ist,
   dadurch gekennzeichnet, daß die eine oder die zwei der Muffen (III) von einer kürzeren Länge sind als die eine oder die zwei der langen Schrauben (II), wobei das äußere Ende einer jeden langen Schraube (II) gemäß einer hexagonalen oder anderen polygonalen Form koaxial ausgespart (12) ist und diese Aussparung sich fortgesetzt durch eine mit einem Schraubengewinde versehene Bohrung (13) die konzentrisch zu der Schaftachse verläuft, wobei das äußere Ende einer jeden Muffe (III) versehen ist mit wenigstens zwei Vertiefungen (16) für den Eingriff eines Schraubenziehers, und eine jede der schrägen Bohrungen (5) ist mit einem Schraubengewinde versehen und das äußere Ende einer jeden Muffe ist mit einem Schraubengewinde (15) ausgestattet das dem Schraubengewinde in der schrägen Bohrung in der Verbindungsplatte entspricht,

eine jede der langen Schrauben (II) ist entlang dem Umfang mit einem Absatz (17) versehen, und dabei ist das innere Ende (18) einer jeden Muffe nach innen umgefalzt, um die Schraube daran zu hindern aus der Muffe heraus zu gleiten, infolge des Kontaktes des Absatzes mit dem umgefalzten Ende, und daß die Vorrichtung darüber hinaus wenigstens zwei kürzere Schrauben (33) umfaßt, zum Befestigen der Verbindungsplatte (I) mit dem Oberschenkelschaft, wobei sich dieselben durch die geraden Bohrungen (7) hindurch in das Knochenmaterial hinein erstrecken.

2. Kombination einer chirurgischen Vorrichtung gemäß Anspruch 1 mit einem Hilfsgerät das dazu dient, die chirurgische Vorrichtung einzuführen und dieselbe mit einem gebrochenen Knochen zu verbinden, dabei umfaßt das Hilfsgerät:

einen winkelförmigen Verbindungsarm (IV) mit einem kurzen horizontalen Abschnitt (20) zum Verbinden des Kopfteiles der Verbindungsplatte sowie mit einem längeren senkrechten Abschnitt (21), der sich parallel zu dem geraden unteren Teil der Platte erstreckt, worin der horizontale Abschnitt mit einer axialen Durchbohrung ausgestattet ist für den Durchgang einer Schraube (22), die mit der mit einem Schraubengewinde versehenen Bohrung (3) in dem Kopfteil der Platte in Eingriff steht und so gestaltet ist, daß sie sich an die Form des Kopfteiles anpaßt, um eine absolute Parallelität zwischen dem senkrechten Abschnitt (21) und der Verbindungsplatte zu sichern, und worin der senkrechte Abschnitt versehen ist mit einer oder mit zwei aneinander grenzenden, schräg verlaufenden Bohrungen (26), die koaxial ausgerichtet sind in Bezug auf die genannten eine oder zwei mit Schraubengewinden versehenen Bohrungen (5) in der Verbindungsplatte, und mit wenigstens zwei geraden Bohrungen (27), die koaxial ausgerichtet sind in Bezug auf die genannten wenigstens zwei gerade Bohrungen (7) in der Platte;
eine erste röhrenförmige Führung (31) mit einem Außendurchmesser der mit den genannten eine oder zwei schrägen Bohrungen (26) in dem Verbindungsarm zusammenwirkt, und mit einem Innendurchmesser entsprechend dem Außendurchmesser der genannten eine oder zwei Muffen, welche die genannten eine oder zwei langen Schrauben umhüllen, und mit einer Länge die verträglich ist mit der Entfernung zwischen den jeweiligen schrägen Bohrungen in der Platte und dem Arm;
ein erstes auswechselbares Rohr (32) zum Einführen in die röhrenförmige Führung und zum Einschrauben in die schräge Bohrung in der Verbindungsplatte, mit einem Innendurchmesser entsprechend dem Außendurchmesser eines Führungsdrahtes (30) der durch dieselbe hindurch in den gebrochenen Knochen gestoßen wird;
ein zweites auswechselbares Rohr zum Einführen in die röhrenförmige Führung und zum Einschrauben in die schräge Bohrung in der Verbindungsplatte, mit einem Innendurchmesser entsprechend dem Durchmesser eines Bohrers zum Vorbohren des Knochens;
einen Führungsdraht (30), der dazu bestimmt ist durch die Bohrung in dem ersten auswechselbaren Rohr hindurch gestoßen zu werden;
einen Bohrer, der dazu bestimmt ist durch die Bohrung in dem zweiten auswechselbaren Rohr in das Knochenmaterial hinein eingeführt zu werden;
eine zweite kürzere röhrenförmige Führung zum Einführen in die geraden Bohrungen (27) in dem Verbindungsarm, mit einer Länge die verträglich ist mit der Entfernung zu der Verbindungsplatte, und mit einem Innendurchmesser der passend ist für den Durchgang eines Bohrers der bestimmt ist zum Vorbohren des Knochens für die Aufnahme der kürzeren Schrauben (33);
einen Schraubenzieher (V) zum Einführen und Befestigen der genannten eine oder zwei langen Schrauben, der sich zusammensetzt aus einem inneren Schaft (40) mit einem mit einem Schraubengewinde versehenen inneren Ende (41) für das Eingreifen in die mit einem Schraubengewinde versehene Bohrung (13) in dem ausgesparten Ende einer jeden der genannten eine oder zwei langen Schrauben, mit einem mittleren röhrenförmigen Schaft (43), der mit einem polygonalen inneren Ende (44) für den Eingriff in die polygonale Aussparung (12) in jeder langen Schraube versehen ist, und mit einem äußeren röhrenförmigen Schaft (47), der an seinem inneren Ende mit hervorstehenden Zähnen (48) ausgestattet ist, zum Eingriff in die Vertiefungen (16) in den genannten eine oder zwei Muffen, welche die genannten eine oder zwei langen Schrauben umhüllen, worin alle drei Schäfte unabhängig von einander in der axialen Richtung und in der Umdrehungsrichtung beweglich sind mittels Handgriffen (42, 45, 49) die an deren äußeren Enden befestigt sind und in denen helikoidale Federn (50, 51) vorgesehen sind um die axiale Ausrichtung der jeweiligen Schäfte einzustellen.

3. Chirurgische Vorrichtung gemäß Anspruch 1, worin die Vorrichtung zwei aneinander grenzende

schräge Bohrungen (5), zwei lange Schrauben (II) und zwei Muffen (III) aufweist.

4. Kombination des Hilfsgerätes nach Anspruch 2 und der chirurgischen Vorrichtung nach Anspruch 3, worin der senkrechte Abschnitt ausgestattet ist mit zwei aneinander grenzenden, schräg gerichteten Bohrungen (26), die koaxial ausgerichtet sind in Bezug auf die mit einem Schraubengewinde versehenen zwei Bohrungen (5), und das Hilfsgerät eine Paar der ersten röhrenförmigen Führungen aufweist, die mit den schrägen Bohrungen in dem Verbindungsarm zusammenwirken.

5. Chirurgische Vorrichtung gemäß Anspruch 3, worin der äußere Abschnitt der Verbindungsplatte, welcher die schräg verlaufenden, mit einem Schraubengewinde versehenen Bohrungen umgibt, in der Form von zwei schrägen Ansätzen (6), die aus der Plattenoberfläche herausragen, verdickt ist.

6. Chirurgische Vorrichtung gemäß Anspruch 3, worin der Kopfteil (2) der Verbindungsplatte (I) nach außen gebogen ist, um sich dem Umriß des Oberschenkelknochens anzupassen, und worin der Kopfteil perforiert ist durch die mit einem Schraubengewinde versehene Bohrung (3) und durch wenigstens eine glatte Bohrung (4), wobei beide Bohrungen senkrecht zu der Achse der Verbindungsplatte verlaufen.

7. Chirurgische Vorrichtung gemäß Anspruch 3, worin die innere Oberfläche des Kopfteiles der Verbindungsplatte sich nach außen abschrägt (102) entsprechend dem Umriß des Oberschenkelknochens.

8. Chirurgische Vorrichtung gemäß Anspruch 3, worin die äußere Oberfläche des Kopfteiles der Verbindungsplatte konvex ist.

9. Chirurgische Vorrichtung gemäß Anspruch 4, worin der senkrechte Abschnitt des Verbindungsarmes mit Regelschrauben (28) versehen ist, die dazu dienen die röhrenförmigen Führungen festzuhalten.

10. Chirurgische Vorrichtung gemäß Anspruch 4, worin das innere Ende (120) des horizontalen Abschnittes des Verbindungsarmes konkav ist, um dem konvexen Kopfteilabschnitt der Verbindungsplatte zu entsprechen.

11. Chirurgische Vorrichtung gemäß Anspruch 4, worin das untere Ende des senkrechten Abschnittes des Verbindungsarmes mit Hilfsmitteln (28, 29) ausgestattet ist zum Halten einer stabförmigen Zielvorrichtung (60, 61, 62).

12. Chirurgische Vorrichtung gemäß Anspruch 11, worin die Zielvorrichtung einen Zielstab (60) aufweist, der rechtwinklig mit einer Verbindungsstange (61) verbunden ist, wobei die Verbindungsstange so angepaßt ist, daß sie an dem unteren Ende des senkrechten Abschnittes des Verbindungsarmes angebracht ist, unter Einsatz von Hilfsmitteln die eine Regelung der Winkelrichtung des Zielstabes erlauben.

13. Chirurgische Vorrichtung gemäß Anspruch 4, worin der Schraubenzieher mit Hilfsmitteln ausgestattet ist zum Ziehen des mit einem Schraubengewinde versehenen Endes (41) des inneren Schaftes (40) in den äußeren röhrenförmigen Schaft (47), was dazu dient die lange Schraube in Bezug auf die Muffe in die nach außen orientierte Richtung zu ziehen.

14. Chirurgische Vorrichtung gemäß Anspruch 4, worin der Schraubenzieher mit einer äußeren Muffe (56) versehen ist, die durch einen auswechselbar Stift (57) in Position gehalten wird und die in Eingriff steht mit dem äußeren röhrenförmigen Schaft (47) mit Hilfe eines Stiftes (59) der entlang einer am Umfang verlaufenden Vertiefung (58) auf der Außenseite der Muffe bewegt werden kann.

15. Chirurgische Vorrichtung gemäß Anspruch 4, worin die Schraube (22), die sich durch den horizontalen Abschnitt des Verbindungsarmes hindurch erstreckt, mit einem Griff (23) an ihrem äußeren Ende versehen ist und in ihrer Mitte durchbohrt ist, um den Durchgang für einen scharfen Stift oder eine scharfe Schraube (25) zu ermöglichen, welche dazu bestimmt ist zwecks einer genauen Befestigung des Verbindungsarmes in den Knochen gedrückt zu werden.

Revendications

1. Dispositif chirurgical pour l'assemblage percutané d'une partie supérieure fracturée de fémur à la tige fémorale, le dispositif comprenant les composants suivants destinés à rester dans le corps:

   une plaque d'assemblage en forme de barre (I) possédant une surface interne devant être placée sur l'os, une surface externe, une partie supérieure et une partie inférieure munie d'une extrémité pointue (8) en vue de son insertion par une petite incision cutanée, ladite plaque d'assemblage étant munie dans sa partie inférieure d'au moins deux perçages fraisés transversaux (7) et dans sa partie supérieure d'un ou de deux perçages obliques (5) de diamètre plus large orientés dans la direction montante sous un angle d'environ 130°, un perçage

taraudé (3) perpendiculaire à . l'axe dudit assemblage en forme de barre étant prévu dans ladite partie supérieure;

une ou deux vis longues (II) et un ou deux manchons (III), chacune desdites une ou deux vis longues (II) possédant une tige droite (10), une extrémité interne en forme de vis à bois (11) pour une insertion dans ladite partie d'os fracturée ainsi qu'une extrémité externe, la partie de l'extrémité externe de chacune desdites vis étant placée et mobile dans les deux directions axiale et rotationnelle dans le manchon (III),

caractérisé en ce que lesdits un ou deux manchons (III) ont une longueur plus petite que lesdites une ou deux vis longues (II) l'extrémité externe de chaque vis longue (II) étant évidée de façon coaxiale (12) sous une forme hexagonale ou une autre forme polygonale, ledit évidement étant prolongé par un perçage taraudé (13) concentrique avec ledit axe de la tige, l'extrémité externe de chaque manchon (III) étant munie d'au moins deux évidements (16) en vue de l'engagement d' un tournevis, et chacun desdits perçages obliques (5) sont taraudés et l'extrémité externe de chaque manchon étant prévue avec un filetage (15) correspondant au taraudage dans ledit perçage oblique dans ladite plaque d'assemblage, chacune desdites vis longues (II) est munie d'un pas en circonférence (17) alors que dans celui-ci l'extrémité interne (18) de chaque manchon est sertie vers l'intérieur, pour empêcher ladite vis de glisser en dehors dudit manchon, en raison du contact dudit pas avec ladite extrémité sertie, et le dispositif comprenant en outre au moins deux vis plus courtes (33) pour fixer ladite plaque d'assemblage (I) à la tige du fémur, s'étendant à travers lesdits perçages droits (7) dans le matériau de l'os.

2. Combinaison d'un dispositif chirurgical suivant la revendication 1 et d'un équipement supplémentaire servant à insérer et à assembler ledit dispositif chirurgical à un os fracturé, l'équipement supplémentaire comprenant :

un bras d'assemblage angulaire (IV) comprenant une partie horizontale courte (20) pour un assemblage de la partie supérieure de ladite plaque d'assemblage et une partie verticale plus longue (21) s'étendant parallèlement à la partie inférieure droite de ladite plaque, dans lequel ladite partie horizontale est munie d'une perforation axiale pour le passage d'une vis (22) s'engageant dans ledit perçage taraudé (3) dans ladite partie supérieure de ladite plaque et est dimensionnée pour coïncider avec la forme de ladite partie supérieure de façon à assurer un parallélisme parfait de ladite partie verticale (21) avec ladite plaque d'assemblage, et dans lequel ladite partie verticale est munie d'un ou deux perçages contigus orientés dans la direction oblique (26) alignés de façon coaxiale avec lesdits un ou deux perçages taraudés (5) dans ladite plaque d'assemblage et d'au moins deux perçages droits (27) alignés de façon coaxiale avec lesdits au moins deux perçages droits (7) dans ladite plaque;

un premier dispositif de guidage tubulaire (31) de diamètre externe coopérant avec lesdits un ou deux perçages obliques (26) dans ledit bras d'assemblage et de diamètre interne correspondant au diamètre externe desdits un ou deux manchons recouvrant lesdites une ou deux vis longues, de longueur compatible avec la distance entre les perçages obliques respectifs dans ladite plaque et ledit bras;

un premier tube amovible (32) destiné à une insertion dans ledit dispositif de guidage tubulaire et à être vissé dans ledit perçage oblique dans ladite plaque d'assemblage, d'un diamètre interne correspondant au diamètre externe d'une tige de guidage (30) devant être poussée à travers celui-ci dans ledit os fracturé;

un second tube amovible destiné à une insertion dans ledit dispositif de guidage tubulaire et à être vissé dans ledit perçage oblique dans ladite plaque d'assemblage, d'un diamètre interne correspondant au diamètre d'un foret pour un perçage préalable dudit os;

une tige de guidage (30) devant être poussée à travers le perçage dans ledit premier tube amovible;

un foret pour être inséré dans le matériau de l'os à travers le perçage dans ledit second tube amovible;

un second dispositif de guidage tubulaire plus court pour une insertion dans lesdits perçages droits (27) dans ledit bras d'assemblage, d'une longueur compatible avec la distance jusqu'à ladite plaque d'assemblage et d'un diamètre interne adapté au passage d'un foret destiné au perçage préalable de l'os pour recevoir lesdites vis plus courtes (33);

un tournevis (V) pour l'insertion et la fixation desdites une ou deux vis longues composé d'une tige interne (40) munie d'une extrémité interne filetée (41) pour un engagement avec ledit perçage taraudé (13) dans l'extrémité évidée de chaque des une ou deux vis longues, d'une tige tubulaire médiane (43) munie d'une extrémité interne polygonale (44) pour un engagement avec ledit évidement polygonal (12) dans chaque vis longue et d'une tige tubulaire externe (47) munie au niveau de son extrémité interne de dents saillantes (48) pour

un engagement avec lesdits évidements (16) dans lesdits un ou deux manchons recouvrant lesdites une ou deux vis longues, dans lequel toutes les trois tiges peuvent bouger indépendamment dans les deux directions axiale et rotationnelle par des poignées (42, 45, 49) fixées à leurs extrémités externes, et dans lequel des ressorts hélicoïdaux (50, 51) sont prévus pour servir à ajuster l'alignement axial des tiges respectives.

3. Dispositif chirurgical suivant la revendication 1, dans lequel ledit dispositif comprend deux perçages obliques contigus (5), deux vis longues (II) et deux manchons (III).

4. Combinaison de l'équipement supplémentaire suivant la revendication 2 et du dispositif chirurgical suivant la revendication 3, dans laquelle ladite partie verticale est munie de deux perçages contigus orientés dans la direction oblique (26) alignés de façon coaxiale avec lesdits deux perçages taraudés (5), et ledit équipement supplémentaire comprend une paire de premiers dispositifs de guidage tubulaires coopérant avec lesdits perçages obliques dans ledit bras d'assemblage.

5. Dispositif chirurgical suivant la revendication 3, dans lequel la partie externe de ladite plaque d'assemblage entourant lesdits perçages obliques taraudés est agrandie sous la forme de deux saillies obliques (6) dépassant de la surface de la plaque.

6. Dispositif chirurgical suivant la revendication 3, dans lequel la partie supérieure (2) de ladite plaque d'assemblage (I) est courbée vers l'extérieur pour coïncider avec le contour du fémur et dans lequel ladite partie supérieure est percée par ledit perçage taraudé (3) et par au moins un perçage lisse (4), les deux perçages étant perpendiculaires à l'axe de ladite plaque d'assemblage.

7. Dispositif chirurgical suivant la revendication 3, dans lequel la surface interne de ladite partie supérieure de ladite plaque d'assemblage présente une pente vers l'extérieur (102) conformément au contour dudit fémur.

8. Dispositif chirurgical suivant la revendication 3, dans lequel la surface externe de la partie supérieure de ladite plaque d'assemblage est convexe.

9. Dispositif chirurgical suivant la revendication 4, dans lequel ladite partie verticale dudit bras d'assemblage est munie de vis de calage (28) servant à fixer lesdits dispositifs de guidage tubulaires.

10. Dispositif chirurgical suivant la revendication 4, dans lequel l'extrémité interne (120) de ladite partie horizontale dudit bras d'assemblage est concave pour correspondre à la partie supérieure convexe de ladite plaque d'assemblage.

11. Dispositif chirurgical suivant la revendication 4, dans lequel l'extrémité inférieure de la partie verticale dudit bras d'assemblage est pourvue de moyens (28, 29) servant à maintenir un dispositif de pointage en forme de barre (60, 61, 62).

12. Dispositif chirurgical suivant la revendication 11, dans lequel le dispositif de pointage comprend une barre de pointage (60) assemblée sous des angles droits à une barre d'assemblage (61), ladite barre d'assemblage étant adaptée pour être attachée à l'extrémité inférieure de ladite partie verticale dudit bras d'assemblage par des moyens permettant un ajustement de la direction angulaire de ladite barre de pointage.

13. Dispositif chirurgical suivant la revendication 4, dans lequel ledit tournevis est pourvu de moyens pour tirer l'extrémité filetée (41) de ladite tige interne (40) dans ladite tige tubulaire externe (47) servant à tirer ladite vis longue dans la direction extérieure par rapport audit manchon.

14. Dispositif chirurgical suivant la revendication 4, dans lequel ledit tournevis est muni d'un manchon externe (56) maintenu en position par un clou amovible (57) et engageant ladite tige tubulaire externe (47) au moyen d'un clou (59) mobile le long de l'évidement en circonférence (58) à l'extérieur dudit manchon.

15. Dispositif chirurgical suivant la revendication 4, dans lequel ladite vis (22) traversant ladite partie horizontale dudit bras d'assemblage est munie d'une poignée (23) au niveau de son extrémité externe et elle est percée en son centre permettant le passage d'un clou ou d'une vis à extrémité affûtée (25) destinée à être poussée dans l'os en vue d'une fixation précise dudit bras d'assemblage.

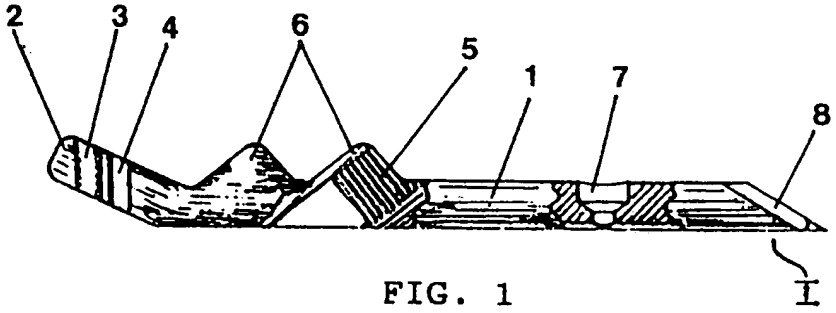

FIG. 1

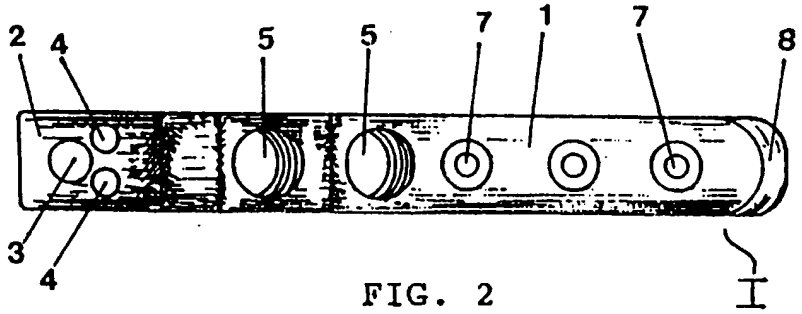

FIG. 2

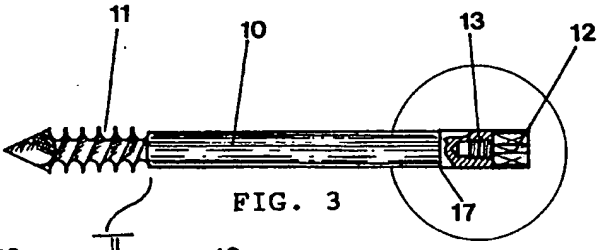

FIG. 3

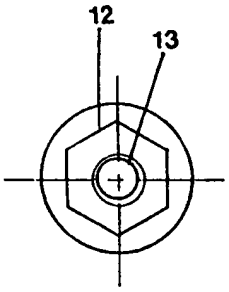

FIG. 5

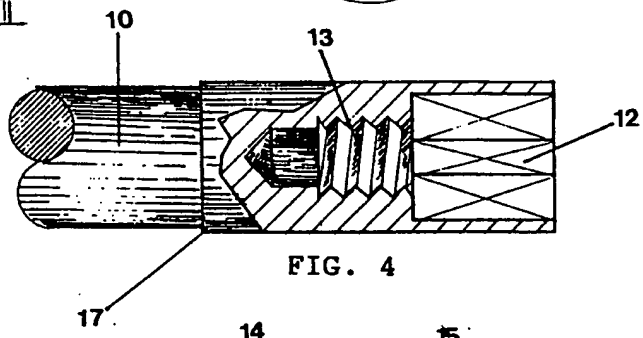

FIG. 4

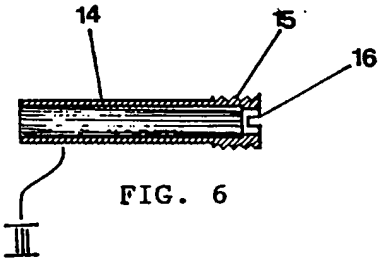

FIG. 6

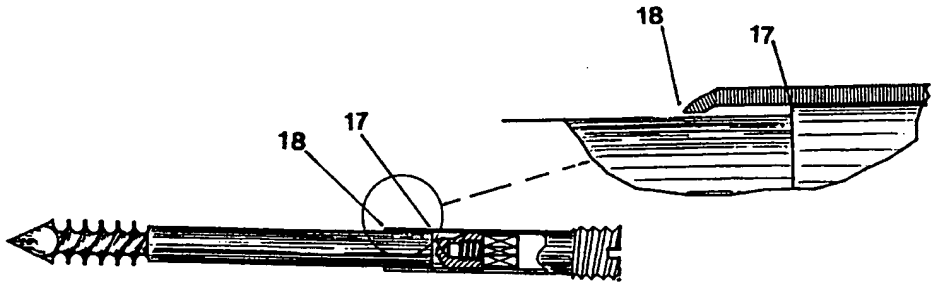

FIG. 7

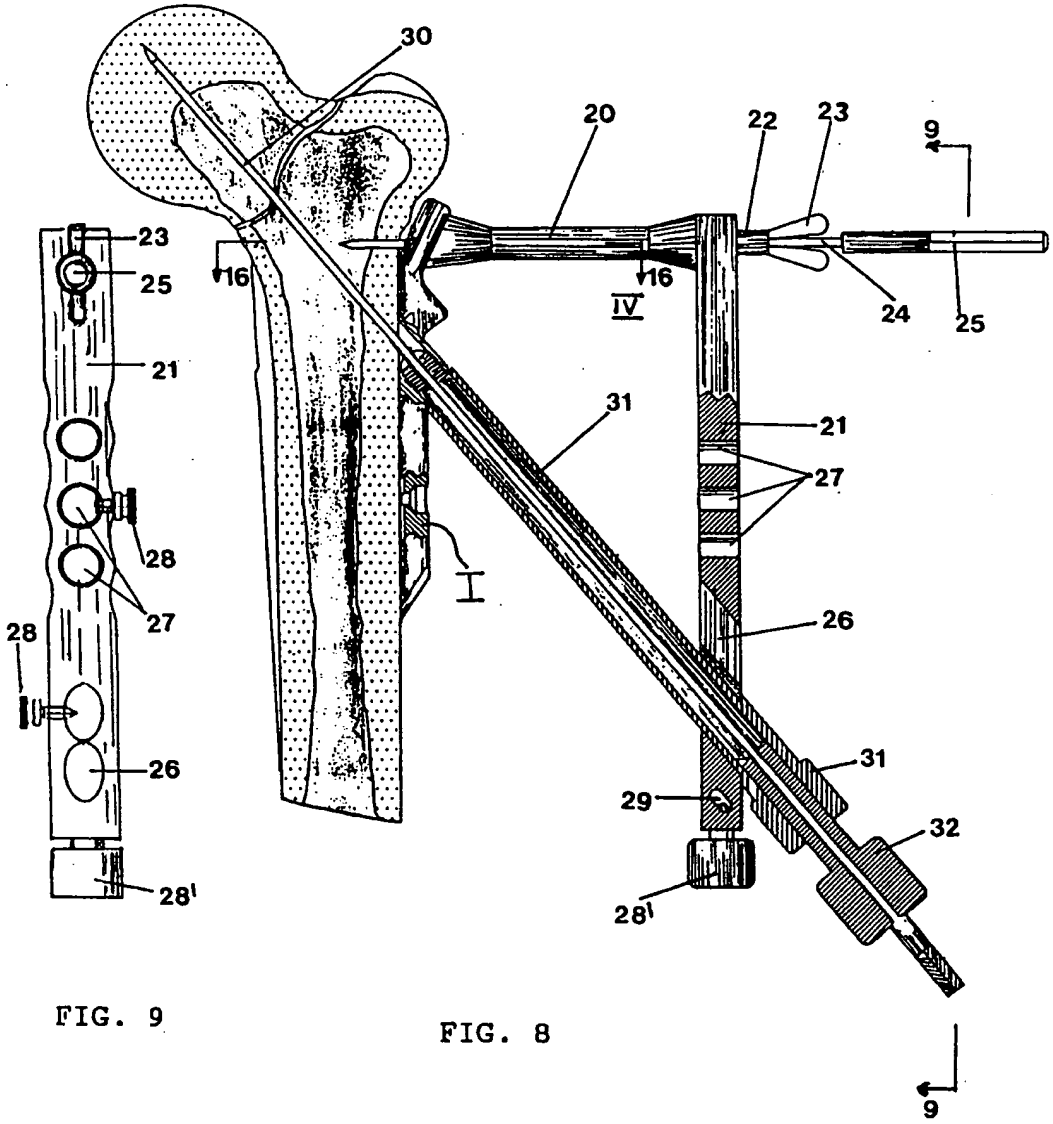
30
20
22
23
9
23
25
16
16
IV
24
25
21
31
21
27
28
I
27
26
28
26
31
29
32
28'
28'
9

FIG. 9

FIG. 8

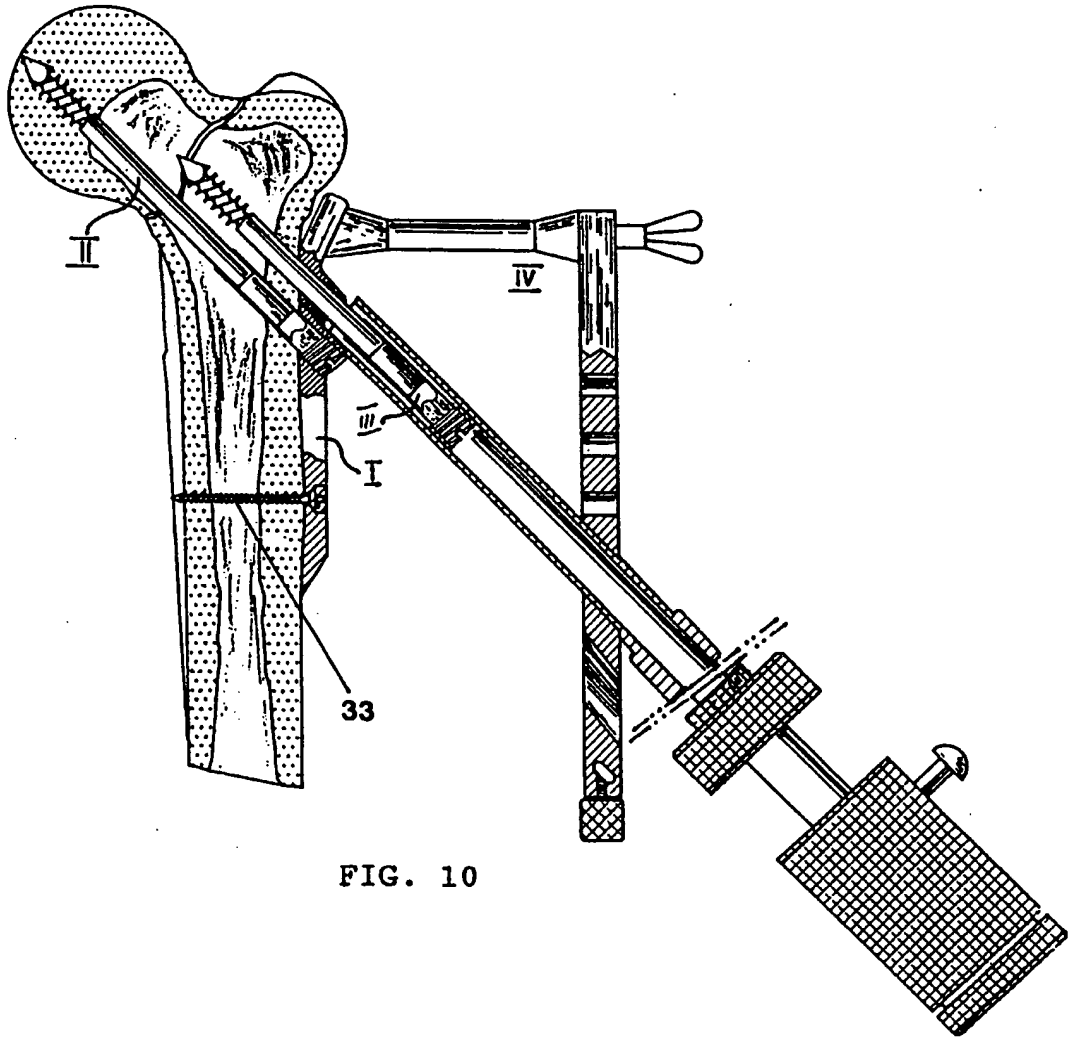

FIG. 10

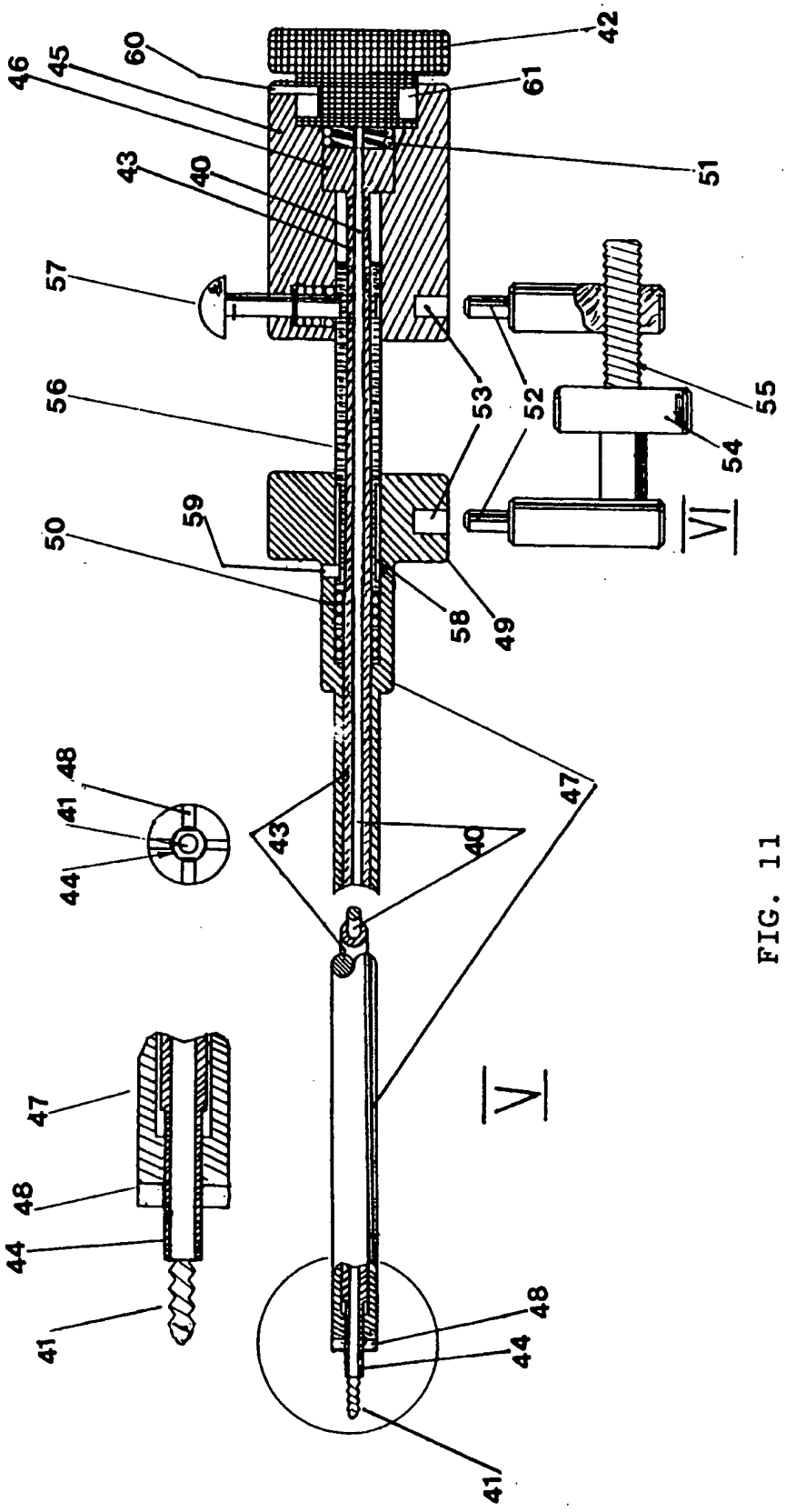
42
60
46
45
61
51
43
40
57
53
52
55
56
54
VI
59
50
58
49
48
41
47
44
43
40
V
47
48
44
41
48
44
41

FIG. 11

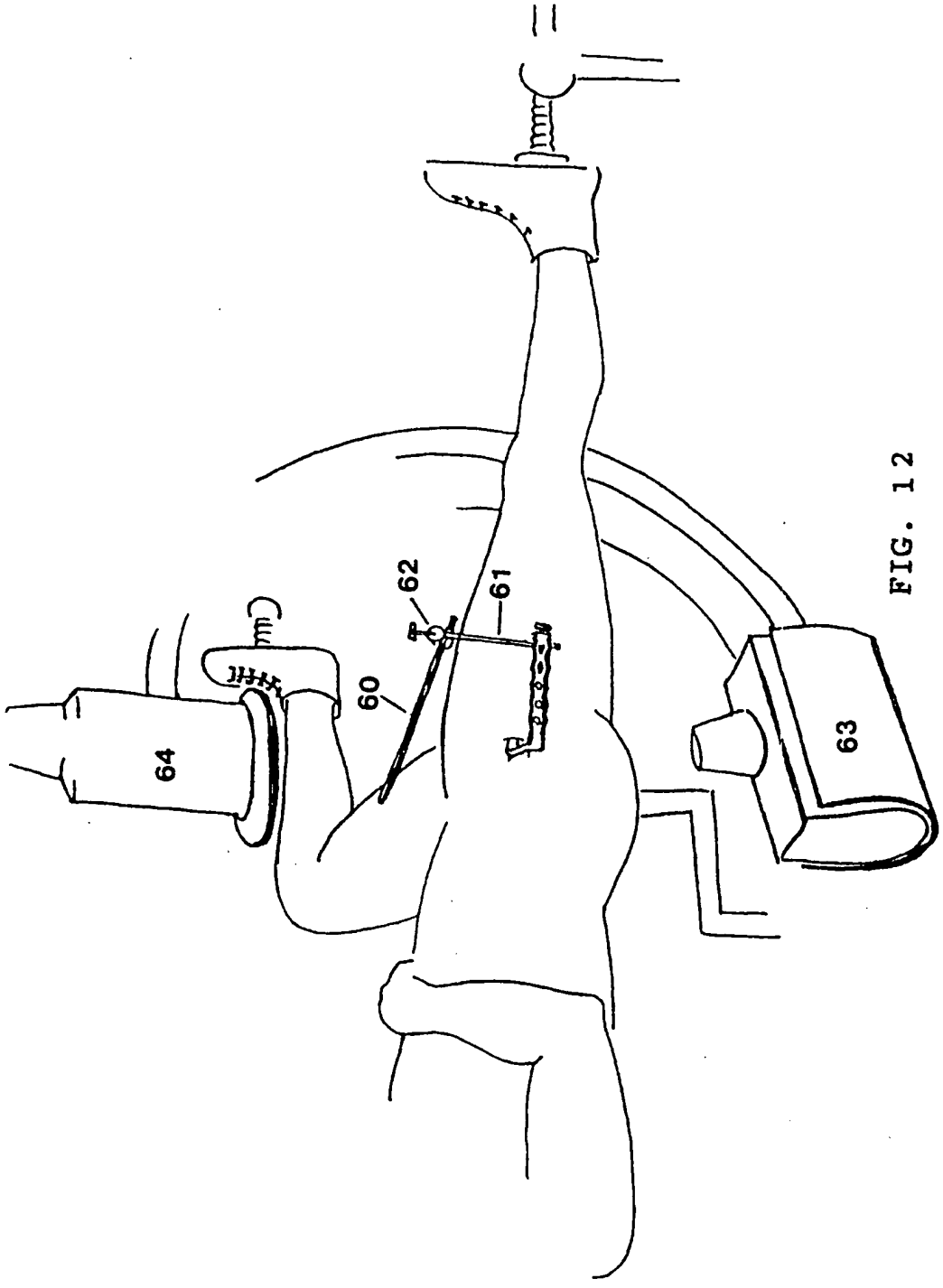

FIG. 12

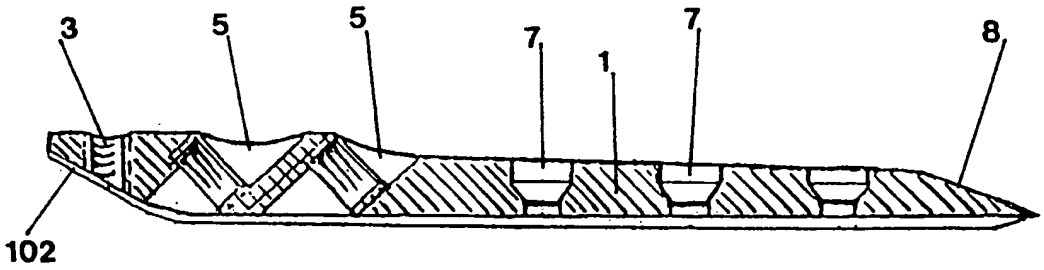

FIG. 13

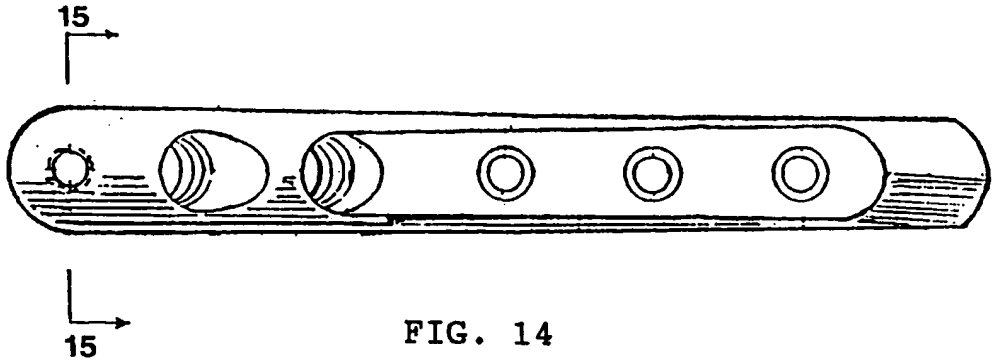

FIG. 14

FIG. 15

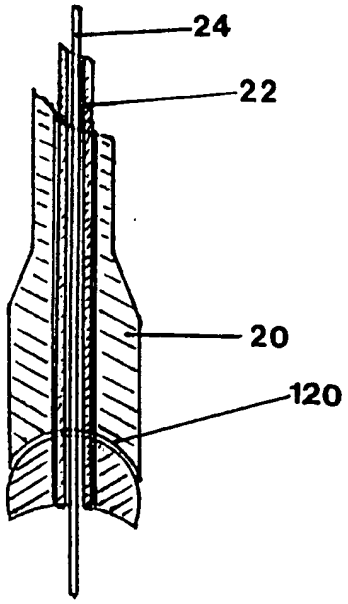

FIG. 16

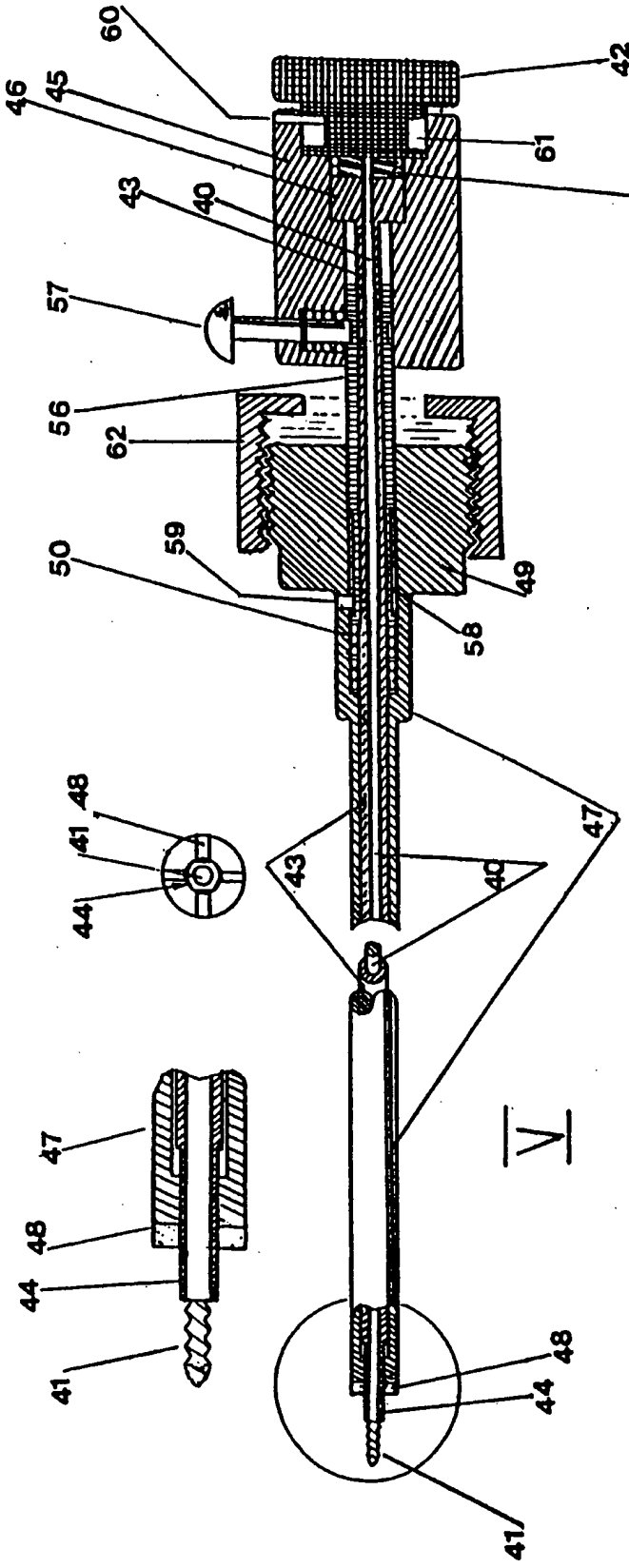
60
46
45
42
61
51
43
40
57
56
62
59
50
49
58
48
41
44
47
V
V
47
48
44
41
48
44
41

FIG. 17